The Baltimore and Ohio Railroad Company

SIGNAL DEPARTMENT.

S. E. No. 120

BULLETIN NO. 57

Baltimore, Md., May 1, 1921.

INSTALLATION OF CONTROLLED MANUAL BLOCK SYSTEM AND POSITION COLOR LIGHT SIGNALS, MT. ROYAL AND CAMDEN STATIONS, BALTIMORE, MD.

After putting in operation the Baltimore Belt Railroad in 1894, (which is a section of the main line extending from Camden Station to Bay View, Baltimore, a distance of 6.9 miles), an interlocking plant was installed in 1896 at Mount Royal Station and later at three other points, viz: North Avenue, Huntingdon Avenue, (east end of 4 tracks), and Waverly, the east limit of the electrified section.

"RM" Tower, Mount Royal Station Interlocking.

The plant at Mount Royal Station operates the switches and necessary signals for the protection of a double track junction at the west end of four tracks, that part of the line having four tracks from Mount Royal Station to Huntingdon Avenue, a distance of .9 miles, the remainder of the line having two tracks. The junction switches at Mount Royal are in the east mouth of the Howard Street tunnel.

The original interlocking installation was made by the Johnson Railroad Signal Company of Rahway, N. J., under contract, and which was the second machine of type "A" design made and installed, hence this machine has seen 26 years continuous service, and is at this time in good condition. It has, of course, been rearranged and overhauled from time to time as the necessity arose.

The installation costs were as follows, not including the tower:

Cost per lever (36) levers	$147.95
Cost per working lever (32)	166.44
Cost per unit (50)	106.52
Total Cost	$5326.37

Drawing No. 305-7 shows the track and signal arrangement as completed in 1896.

On April 16, 1920 the laying of 130 pound rail through the switches at Mount Royal Station made it necessary to install detector circuits, superseding the use of detector bars, it not being possible to make these bars effective with that weight of rail.

"CA" Tower, Camden Belt Line Station Interlocking.

A small mechanical interlocking was installed at this point in 1897, for the control of five signals, one derail and two switches, the cost of installation being relatively small, because the tower existed at that time and all the material used was second class.

Manual Block.

When the Baltimore Belt Railroad was put in operation, manual block was made effective, the use of which between Waverly and Camden Station, was supplemented by the application on April 3, 1912 of a Line Control Block System and which is still in service between Mount Royal Station and Waverly, (automatic signals between Waverly and Bay View having been installed in 1901).

In the use of the manual block, the Morse Code was the means of transmitting information as to traffic movements.

With the installation of the line control, the method of transmitting this information was by Bell Code, and the requesting, receiving, accepting or cancelling by Bell Code is still in effect, having been proved to be the quickest method of handling such.

Line Control Block carries with it no track circuit control, although physical control through the medium

Manual Block (Continued).

of electric locks applied to the signal levers provides a check between operators and consequently before a signal can be caused to indicate proceed, (in the assigned direction), it is first necessary for the operator at the other end of the block to give a release when the signal lever at the sending end is released.

Controlled Manual Block.

On April 1, 1921, controlled manual block in conjunction with position color light signals were made effective for the protection of the Howard Street Tunnel between Mount Royal and Camden Stations.

The signals protect that portion of the tracks between the westbound home signals in the train shed at Mount Royal Station and the eastbound signals at the west end of the Howard Street Tunnel at Camden Belt Line Station. The tunnel (double track) is 7,340 feet in length. Permissive signals are not used over this section.

The following plates and drawings refer to the details of the installation at Mount Royal Station and in the tunnel:

Fig. 1. Interior of tower, interlocking machine and indicators.
Fig. 2. Position color light signals indicating stop.
Fig. 3. Signal governing No. 2 track indicating proceed, approach next signal prepared to stop, restricted speed route.
Fig. 4. Signal governing No. 2 track indicating proceed, approach next signal prepared to stop, main route.
Fig. 5. Signal in tunnel governing eastbound from No. 1 track indicating stop.
Fig. 6. Signal in tunnel governing eastbound from No. 1 track indicating proceed, approach next signal prepared to stop, restricted speed route.
Fig. 7. Signal in tunnel governing eastbound from No. 1 track indicating proceed, clear, restricted speed route.
Fig. 8. Signal in tunnel governing eastbound from No. 1 track indicating proceed at slow speed prepared to stop short of train or obstruction.
Drawing 305-1-C. Tracks and Signals as now existing.
Drawing 305-A-1. Light Signals and Supports.
Drawing 305-A-6. Tunnel Light Signals and Supports.
Drawing 305-2-A. Locking Sheet.
Drawing 305-4-A. Dog Chart.
Drawing 305-6. Sheet 1, Cable Diagram.
Drawing 305-6. Sheet 2, Simplified Circuits.
Drawing 305-6. Sheet 3, Spring Combinations.
Drawing 305-6. Sheet 4, Relay Rack Wiring.
Drawing 305-6. Sheet 5, Relay Box wiring at Signal No. 6
Drawing 191. Bell Code.

The following plates and drawings refer to the details of the installation at the west end of the tunnel, Camden Station:

Fig. 9. Interior of tower, interlocking machine and the electrically locked semaphore indicators; the latter are used in connection with the controlled manual block.
Fig. 10. Position color light signals governing eastbound at west portal of tunnel, Camden Station, indicating stop.
Fig. 11. Position color light signal governing eastbound track indicating proceed, prepare to stop at next signal.
Fig. 12. Position color light signal governing eastbound track indicating proceed clear.
Drawing 307-1. Tracks and Signals.
Drawing 152-A. Electrically Locked Semaphore Indicator and Circuit Controlled, also equipped with mechanical locking between levers.
Drawing 307-6. Sheet 1, Cable Diagram and Relay Box Wiring at West Portal of Tunnel.
Drawing 307-6. Sheet 2, Simplified Circuits.
Drawing 307-6. Sheet 3, Spring Combination and Mechanical Locking.
Drawing 307-6. Sheet 4, Relay Rack Wiring in Tower.

Position Color Light Signals.

It is not generally realized that position and color light signaling was used on the Boston and Albany and the Old Colony Railroads as far back as 1886, and at that time the writer assisted in the installation of such signals on the Boston and Albany Railroad, although they were used only for night indications, the arms serving for the day indications. The night indications then displayed were as follows:

Position Color Light Signals (Continued).

BOSTON AND ALBANY RAILROAD.

Home Signals, Two White lights. Horizontal-Stop.
Distant Signals, Two Green lights, Horizontal-Caution.
Home and Distant Signals, Two Green lights, Vetical-Clear.

OLD COLONY RAILROAD.

Home Signal, Two Red lights Horizontal-Stop.
Distant Signal, Two Green lights, Horizontal-Caution.
Home and Distant Signals, Two White lights, Vertical-Clear.

The foregoing goes to show how difficult it is to really produce absolutely new ideas, because in research of past practices something may generally be found which establishes the thought that the subject had been previously reviewed and possibly tried out. Our particular problem then is to get more exacting and practical results from the application of such ideas, and which it is expected to point out in the following remarks.

Since it has been definitely demonstrated, after many years of use, that at night colored lights have satisfactorily provided the means of transmitting various degrees of information and instruction to trainmen, it is safe to assume that a continuation of a system of colored night signals is in line with good practice and can be relied upon as a distinct means of indicating to trainmen what action in the handling of their trains should be taken by them when such indications are displayed.

Colored lights having proved their utility as night signals, there is no good reason why such cannot be expanded and use the same colors for daylight service, eliminating the arms and other moving parts, provided sufficient volume and intensity of light is displayed, and if, without any possibility of a doubt, such distinctness in colored lights for daylight signaling is now available, there is no argument against such a system being largely used and standardized and thus produce a means of simplifying the reading of indications as well as to reduce the cost of construction and subsequent maintenance and operation.

Our present system is such as to require for daylight signaling the use of arms, variably positioned according to track conditions or such other information required to be transmitted to trainmen, viz: horizontal, diagonal or vertical. At night these arms, (whilst required to operate in conjunction with the lights displayed), are not of use, as the instructions and information transmitted to trainmen are through the medium of colored lights. viz: Red, Yellow, Green:

Red being the equivalent of the arm horizontal.
Yellow being the equivalent of the arm diagonal.
Green being the equivalent of the arm vertical.

It will be recognized at once that these day and night indications differ from each other very materially, in that by day the position of the arm transmits the information, whereas, at night the color of the light serves the same purpose. The use of both, consequently, is not such as to simplify the language of signals but instead complicates it. Then again in certain instances the same position of arm and color of light are used to indicate two different conditions, which whilst permissible, cannot be accepted as the best practice and these differences and discrepancies are expected to be corrected and the requirements fully covered in the new system of position color light signals. The present combination system of using arms by day and lights by night requires the memorizing of innumerable aspects. One red light, or two or three red lights in vertical line now constitute the night stop indication, whereas by day, such arms are displayed horizontally for the stop indicat ion, hence a variance which is not consistent, and whilst it is thoroughly understood, does not by any means prove its correctness.

Then again under the present system, we have no distinctive permissive night signal, as in the use of the ordinary manual block signal, the arm at 45 degrees, the same color light, (Yellow) is displayed, indicating "Proceed, block occupied" as is displayed in automatic block signal territory, indicating: "Prepare to stop at next signal;" hence, there is here room for improvement, and a change can be made to more clearly define the action required under the respective indications displayed.

There seems to be no doubt but that the use of colored lights for night signaling has successfully and safely met the requirements; they are now used and will continue as standard practice for many years; their efficiency, therefore, needs no further substantiation. This being the case, and seeing that we are now able to apply a system of distinct readable colored light aspects for daylight signaling, there is no valid reason why we should continue to install complicated mechanisms, either mechanical or electrical, for the purpose of operating signal arms.

Position Color Light Signals (Continued).

The colored lights in the proposed system will be the same as those used in the present system, viz: Red, Yellow, Green, with the addition of Lunar White (a new distinct signal) proposed to be used for the purpose of route markers, and Purple (a well known color) later proposed to be used as a permissive indication and for slow speed movements, thus assigning and holding for the three primary needs, the three colors first mentioned and now used.

Granted that arms displayed at various angles properly transmit the desired information to trainmen, it being conceded that present practice in day signaling is good, distinct and understandable, it is, therefore, logical to assume that to display these indications by means of the various angularities of lights is following along the lines of good practice. With this as a basis, the following angularities of lights can readily be accepted as better filling our needs, both for day and night signaling, viz:

Two Red lights in horizontal line.....Stop.

PRESENT:

One Yellow light.....Proceed at slow speed, Permissive.

LATER PROPOSED TO BE:

Two Purple lights in diagonal line, right to left.....Proceed at slow speed, Permissive.
Two Yellow lights in diagonal line, left to right .....Proceed, Prepared to Stop.
Two Green lights in vertical line.....Proceed.

With the exception of the additional colors, "Lunar White" and "Purple," it is observed that the same three (3) colors for the purposes required are proposed to be used as is now our practice, hence the ease with which such aspects can be read and understood by trainmen is apparent.

This proposed system it is seen utilizes five (5) colors and four (4) positions to meet the five (5) requirements under the rules, and which cannot be distinctly and properly accomplished otherwise.

Current for position color light signals can be obtained either by the use of battery or from a power source, and their operation and selection is through the medium of relays and circuit controllers as between the lights and the levers, and track conditions affecting them. The principle involved is that of causing the lights to be extinguished or lighted as the route or block conditions, or both, may require. In brief, instead of applying mechanisms with their connections and intricate gearing and parts, lights are used both for day and night signaling.

From a study of the proposed indications in comparison with those now our standard, it must be concluded that the new system with its 14 aspects in its entirety is much simpler than the present system with its 79 aspects. The underlying color principles of present night signaling is not set aside and this renders it much easier to commit to memory where changing from the old to the new system. A runner having absorbed mentally the present night light indications will find no difficulty in assimilating himself to reading the same colors in daylight.

Then again, the angular positioning of the lights is an added factor of distinctness, four (4) angles of lights being provided for the four (4) primary conditions to be met, and which aside from color lends itself to a more conspicuous display of the indications.

The basic arguments in favor of the proposed system are:

(1) The day and night indications are the same.
(2) With aspects indicating proceed at slow speed, proceed at restricted speed, or proceed, no red lights are displayed, therefore, this obviates the necessity of disregarding a stop indication as displayed in conjunction with a proceed indication in our present practice.
(3) Instead of trainmen being required to memorize 79 aspects, they are required to commit to mind but 14.
(4) Lunar White upper and lower route markers for high speed and restricted speed routes respectively, indicate clearly which route is set, in conjunction with the other block indications displayed.
(5) Reduction in the cost of construction, maintenance and operation.

It might here be remarked that position as well as color night signaling should not bind us to the hard and fast rule that color without position cannot be used, because we have positively demonstrated during fifty years of practice that color alone will also satisfactorily provide the night indication, although the angular positioning of such colored lights will make the indications more conspicuous and definite.

It will be noted, therefore, that there are provided for both day and night use, position color light signals, located eastbound at the west mouth of the Howard Street tunnel, Camden Station, eastbound in the

Position Color Light Signals (Continued).

tunnel just before reaching the junction switches, and westbound at Mount Royal Station in the train shed at the foulings.

Although very much cramped for space in the tunnel just west of the junction switches, it was found possible to design and construct small lamp units, which display the same angularities of lights as the outside signals. These tunnel lamps were made in the Company's shops at Mt. Clare, Baltimore, Md.

Because of the electrification of that portion of the line between Camden Station and Waverly, over which all eastbound trains are handled by electric locomotives, the propulsion current used being 750 volts d. c., it was necessary to install alternating current track circuits; therefore, all signals governing tracks into and from the tunnel are semi-automatic and display the stop indication upon any part of the train passing a signal.

Circuits Between "RM" and "CA" Towers.

Referring to simplified drawings file 307-6, sheet 2, "CA" Tower and 305-6, sheet 2, "RM" Tower, the circuits controlling traffic locking and signal indications can be traced as follows:

WESTBOUND TRACK.

The track is divided into three (3) separately insulated sections, viz: A 4 T, relay located in "CA" Tower is fed through track transformer at signal No. 4, A 3 T, relay located at signal No. 4, 3 T, relay located at "RM" Tower. Relays A 3 T and 3 T are fed through track transformer located at the center of the Howard Street tunnel. 26 T relay located at "RM" Tower, fed through track transformer located at the east mouth of tunnel with rail connections at signal No. 36. Other track circuits are similarly arranged, and their operation can be clearly traced by further reference to plans.

TRAFFIC LOCKING.

Controlling the direction of traffic are levers equipped with electric locks; levers are locked in the full normal position only and are themselves mechanically locked reversed by the signal control levers governing into the tunnel. For example, at "CA" Tower, signal lever No. 4 mechanically locks traffic lever No. 3 reversed. At "RM" Tower, signal lever No. 5 as well as other signal levers governing to the westbound track, mechanically lock traffic lever No. 3 reversed. Assuming that all levers are normal, it is impossible after locking up a route, to reverse the signal lever governing over that route until the traffic lever is first reversed. To reverse traffic lever No. 3 at "RM" Tower, request as per Bell Code is made to "CA" Tower, asking for unlock; release button at "CA" Tower is pushed opening relay circuit 3 F, closes battery B 12, through front contact of relay A 4 T R, wire 3 F 8, push-button reversed, wire 3 F 7, traffic lever 3 normal, wire 3 F 6, block repeating stick relay closed, wire 3 F 5, 26 track relay closed, wire 3 F 4, through switch and track circuit selections, wire 3 F 2, traffic lever No. 3 "RM" Tower normal, wire 3 F 1, push-button normal, wire 3 F, coils of 1000-ohm relay, to common. Line relay 3 F at "RM" Tower is now energized, and through its front contact controls, First: a visual light indicator, Second: electric lock on lever No. 3, which lever may then be reversed.

CONTROL OF SIGNAL No. 5 "RM" TOWER.

Traffic lever No. 3 having been reversed, signal lever No. 5 or any other signal lever governing to the westbound track, under proper selection, may also be reversed, and when reversed, controls relay 5 H as follows: positive battery at "CA" Tower, front contact A 4 T R, wire 5 H 6, traffic lever No. 3 normal, wire 5 H 5, front contact A 3 T R, wire 5 H 4, front contact 3 T R, wire 5 H 3, traffic lever No. 3 "RM" Tower reversed, wire 5 H 2, front contact 26 T R, wire 5 H 1, lever No. 5 reversed, wire 5 H, coils of 1000-ohm relay, wire 5 N H, lever No 5 reversed, wire 5 N H 1, traffic lever No. 3 reversed, wire 5 N H 2, front contact track relay 3 T R, wire 5 N H 3, front contact relay A 3 T R, wire 5 N H 4, traffic lever No. 3 at "CA" Tower normal, wire 5 N H 5, front contact A 4 track relay closed, to negative battery. Relay 5 H governs the position color light signals, and when de-energized, causes two (2) red lights to be displayed; when energized, these red lights are extinguished, two yellow and one white lights are then displayed.

The indication locking on lever No. 5 at "RM" Tower is also the same for lever No. 36, these being opposing signals.

The indication circuits start battery through back contact of relay 36 H R, wire 5 M L 3, back contact relay 36 B R, wire 5 M L 2, back contact relay 5 H R, wire 5 M L 1, battery saving spring lever 5, wire 5 M L, to 35-ohm electric lock, and to common. It will here be noted that tower indicator 5-36 H P, blade horizontal when energized, is fed from this circuit, and indicates clear when either of the controlling relays is energized. Other circuits may be similarly traced.

One traffic wire between towers serves one track in both directions.

One pair of wires, between towers, serves as signal controls for the track in both directions, both positive and negative circuits being broken by the governing apparati.

The mechanical signals in the train shed at Mount Royal Station, (which had operated successfully for 26 years, were of lower-quadrant type, Baltimore and Ohio spectacle castings 25-10) were superseded by these position color light signals. The original mechanically operated signals were part wire, part pipe-connected, suspended in the train shed on wood masts. East bound just west of the twin tunnel, and westbound east of the twin tunnel, mechanically operated signals are continued in service.

DETAILS OF MATERIAL USED.

The following details refer particularly to the material used in connection with this installation:

Electric Machine Locks.

The electric locks (d. c.) for style "A" machine at Mount Royal are supported on bases as per R. S. A. Drawing No. 1358. Coils are wound 35-ohms resistance. Each lock is equipped with six-way circuit controller.

Machine Circuit Controllers.

Electric lock boxes for Style "A" machine, supported by bases, as per R. S. A. Drawing No. 1358, are used for housing circuit controllers in connection with which no electric locks are used, these are six-way.

Circuit controllers of slidetype, 12-way, are used on levers Nos. 13, 22 and 25, housed in standard boxes, and are supported vertically because of lack of space.

Electrically Locked Semaphore Indicator.

The four-way electrically locked semaphore indicator and circuit controller at "CA" Tower is of Style "B," Federal Signal Company's type, equipped with seven-way circuit controllers and the necessary mechanical and electrical locking. There are two (2) levers for signal control and two (2) levers for traffic control. The indication magnets are wound to operate on 110 volts, 60 cycles, a. c. The details are shown on drawing No. 152. On the signal levers, advantage is taken of the semaphore blade, being made to serve the dual function, viz: First: as a back check on the operation of the relay controlling, and Second: as a signal repeater, or, to show whether the signal responds to the movement of the lever.

Alternating Current Track Relays.

Two-position two-element a. c. track relays are in use with local windings 110 volt, 60 cycle, of Model 2, Form "A," Class T 2 R, G. R. S. type, drawings Nos. 36100, 36102, Specification 262.

Direct Current Line Relays.

These are 1000-ohms resistance, neutral, front contacts silver to graphite, back contacts silver to silver, R. S. A. specifications, with contacts as required.

Track Transformers.

The track circuit through the Howard Street tunnel is one section for each track, center fed. Transformers are 550 volt amperes, air cooled, primary 220 volt, 60 cycle, secondary 3, 5, 7, 10 or 12 volts, Fig. 6, Plate H-187, Union Switch & Signal Company.

The track transformers for other circuits are air-cooled, primary 110 volt, 60 cycle, with one secondary winding, 550-volt amperes, Fig. 6, Plate H-187, Union Switch & Signal Company.

Impendance Bonds.

Single and double for D. C. propulsion system, 0.28-ohms at 1.5 volts, 60 cycle, 1500 amperes, per rail, air gap .035, specification 808, Union Switch & Signal Company, and AA, Plate 321.1, Federal Signal Company catalogues.

Rheostats.

Track circuit rheostats are used in lieu of impedance coils and are of G. E. type No. 12716, S. U. 103-A-12.

Signal Lamps.

Peter Gray & Sons (daylight), with 8⅜ roundels, No. 18½-G 36 watt, 110 volt bulbs; lamps fitted with 12″ hoods, R. S. A. lamp brackets.

Tunnel Signal Lamps.

As per Drawing No. 305-A-5, fitted with G-18½, 110 volt, 36 watt bulbs, Standard Edison base, 5⅜″ colored lenses. Hubbel No. 300, 660 watt, 250 volt bases.

Cable.

Nineteen Conductor, through the tunnel, manufactured by the Hazard Manufacturing Company; supported on type "A" safety mine pins No. 14825, Central Electric Company, and porcelain insulators No. 246-J, Central Electric Company, tied in with marlin twine.

Rubber Covered Wire.

No 6 A. W. G. manufactured by the Standard Underground Cable Company.
Nos. 9, 14 and 16 manufactured by the Habirshaw Company.

Current Consumption.

Seeing that power was conveniently obtainable, advantage was taken of this situation, and the current needed for the operation of the signals, track circuits, relays and electric units in the interlocking machines is taken from the Electrical Department's lighting line which extends through the tunnel from Mount Royal to Camden Station.

The current consumption is as follows, based on readings taken July 25, 1921:

Mount Royal Tower:	
Primary 238 volts, current .166 amperes, watts	40
Basement Mount Royal Station:	
Primary 116 volts, current 9 amperes, watts	1044
Center Of Howard Street Tunnel.	
Primary 221 volts, current .332 amperes, watts	73
West End Howard Street Tunnel:	
Primary 220 volts, current .166 amperes, watts	40
Primary 100 volts, current 2.025 amperes, watts	202
"CA" Tower, Camden Station:	
Primary 99 volts, current .75 amperes, watts	74
Total A. C. power consumption in watts	1473
K. W. hours per month	1060.56
A. C. current cost per K. W. hour	.015
Total A. C. current cost per month	$15.91

Batteries.

At "CA" Tower, Camden Station, there are in service 18 cells 500 ampere hour caustic soda battery, the discharge from which is dependent upon the position of the signal levers, but is approximately .040.

Rectifier.

A type "MS" Valley mechanical rectifier, 60 cycle, 110 volt is in operation at Mount Royal Tower

for charging six (6) cells of type D-5 Chloride Accumulator storage battery. Readings taken July 25, 1921, were as follows:

Primary voltage	110
Secondary voltage	12
Current flow to battery	.22 amperes.
Current discharge from battery	.14 amperes.

The cost per k. w. hour for this current being one and one-half cents ($.015); the total consumption for each 24 hour period costs us $.523 cents.

The work was performed by the Railroad Company's forces and following are statements of the costs of installation.

Statements A, B, C and D outline in detail the cost of the installation in labor and material.

STATEMENT A.

Material.	Cost of Material.	Percentage.
Bonding—Impedances	$4,238.11	26.73
Cable	3,990.27	25.17
Relays, Electric Locks, Circuit Controllers	3,041.47	19.19
Signals	2,253.80	14.21
Conduit	573.04	3.61
Tools	399.93	2.52
Transformers	359.60	2.27
Outside Wiring	343.83	2.17
Inside Wiring	298.52	1.88
Interlocking	184.67	1.17
Track Connections	71.13	.44
Blue-Printing	33.50	.21
Paint	18.51	.12
Supplies	17.40	.11
Foundation	17.10	.11
Battery Charging Apparatus	15.00	.09
	$15,855.88	100.00

STATEMENT B.

Labor.	Cost of Labor.	Percentage.
Engineering—Supervision	$2,783.53	22.20
Cable	1,927.27	15.37
Signals	1,505.73	12.01
Handling New Material	832.36	6.64
Bonding—Impedances	807.09	6.44
Conduit	792.79	6.32
Outside Wiring	671.61	5.36
Interlocking	550.52	4.39
Relays, Electric Locks, Circuit Controllers	499.33	3.98
Camp	497.67	3.97
Transportation	480.70	3.83
Inside Wiring	325.05	2.59
Rental Camp Cars	253.25	2.02
Handling Old Material	248,04	1.98
Painting	150.15	1.20
Transformers	109.60	.87
Track Connections	49.50	.40
Foundations	35.20	.28
Blue-Printing	15.25	.12
Battery Charging Apparatus	3.50	.03
	$12,538.14	100.00

Office of Signal Engineer
4–25–22.

STATEMENT C.

Labor and Material.	Cost of Material.	Cost of Labor.	Total Cost Material and Labor.	Percentage.
Cable	$3,990.27	1,927.27	5,917.54	20.84
Bonding—Impedances	4,238.11	807.09	5,045.20	17.77
Signals	2,253.80	1,505.73	3,759.53	13.24
Relays, Electric Locks, Circuit Controllers	3,041.47	499.33	3,540.80	12.47
Engineering—Supervision	.....	2,783.53	2,783.53	9.80
Conduit	573.04	792.79	1,365.83	4.81
Outside Wiring	343.83	671.61	1,015.44	3.58
Handling New Material	.....	832.36	832.36	2.93
Interlocking	184.67	550.52	735.19	2.59
Inside Wiring	298.52	325.05	623.57	2.20
Camp	.....	497.67	497.67	1.75
Transportation	.....	480.70	480.70	1.69
Transformers	359.60	109.60	469.20	1.65
Tools	399.93	.....	399.93	1.41
Rental Camp Cars	.....	253.25	253.25	.89
Handling Old Material	.....	248.04	248.04	.87
Painting	18.51	150.15	168.66	.59
Track Connections	71.13	49.50	120.63	.43
Foundations	17.10	35.20	52.30	.19
Blue-Printing	33.50	15.25	48.75	.17
Battery Charging Apparatus	15.00	3.50	18.50	.07
Supplies	17.40	.....	17.40	.06
	$15,855.88	12,538.14	28,394.02	100.00

STATEMENT D.

Labor and Material.	Totals.	Percentage.
Coat of Labor	$12,538.14	44.16
Coat of Material	15,855.88	55.84
Total	$28,394.02	100.00

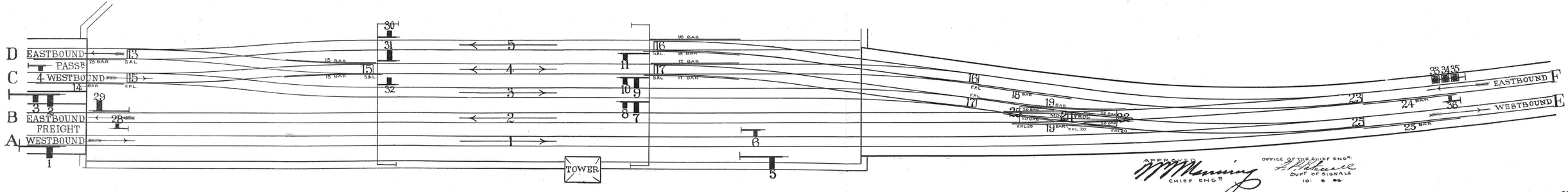
Office of Signal Engineer
4–25–22.

F. P. PATENALL,
Signal Engineer.

B. B. R. R.

MOUNT ROYAL STATION

DIAGRAM OF SIGNALS & SWITCHES.



APPROVED
W. W. Manning
CHIEF ENGR.

OFFICE OF THE CHIEF ENGR.
Supt of Signals

305-7

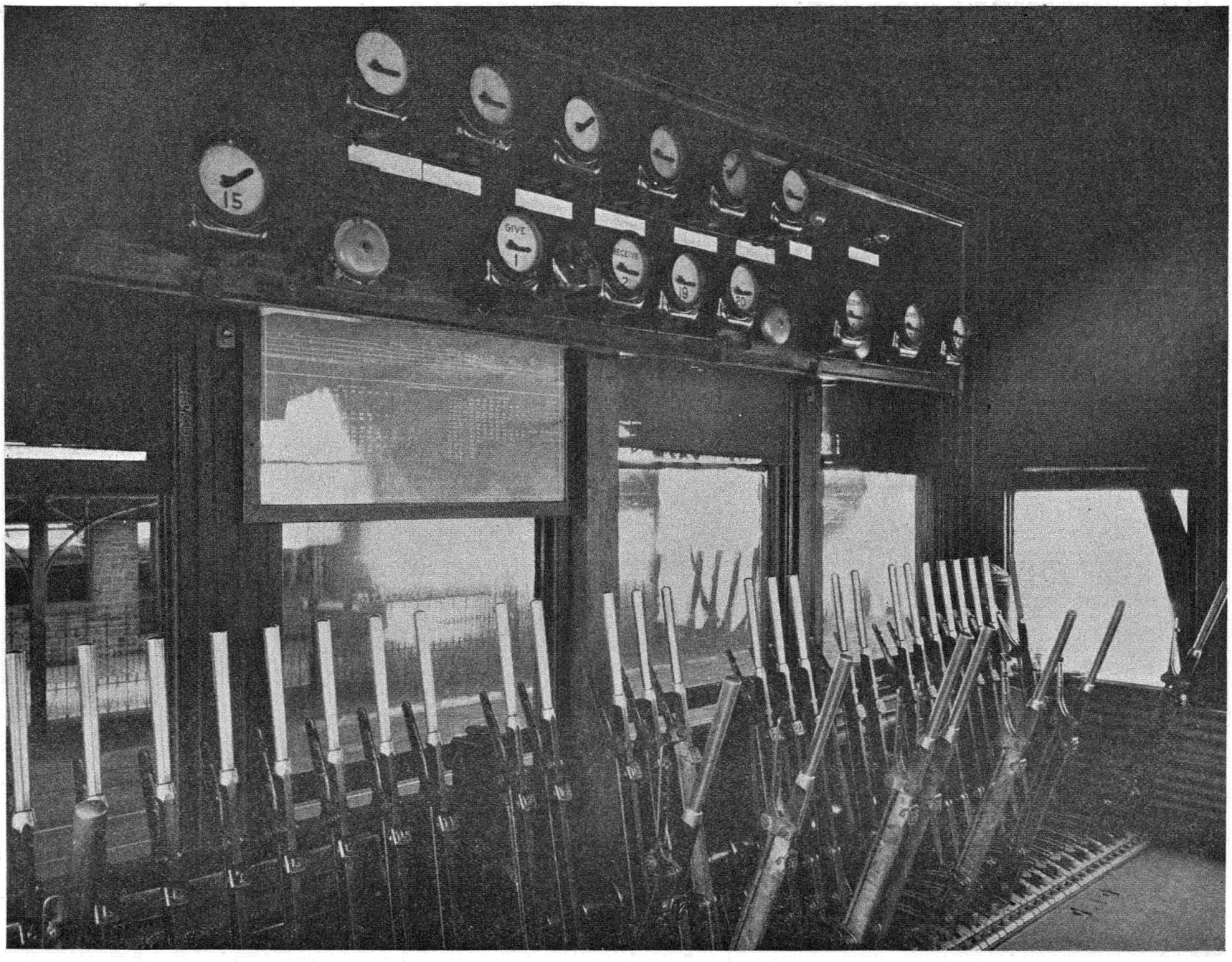


FIG. 1

FIG. 2

FIG. 3

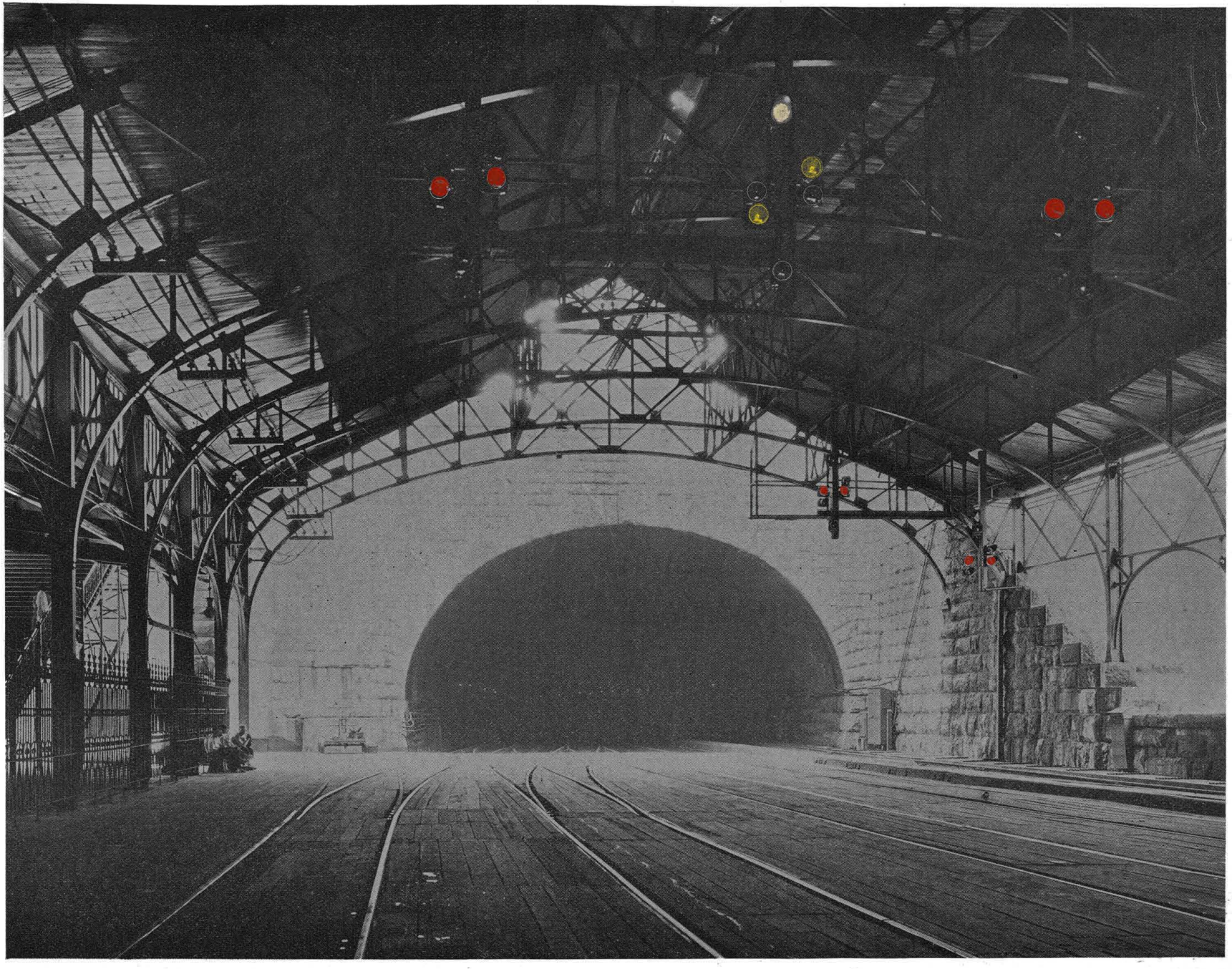


FIG. 4

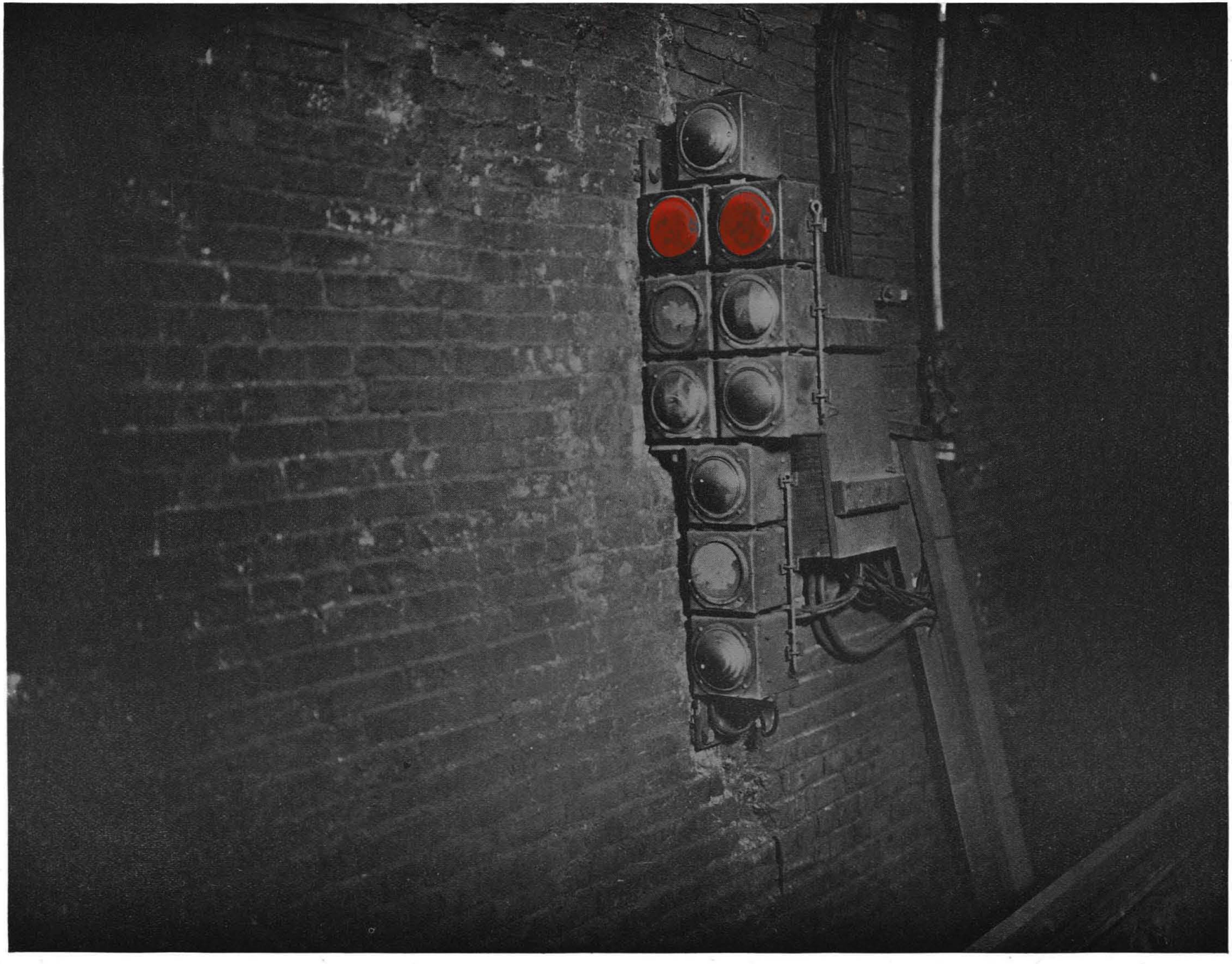


FIG. 5

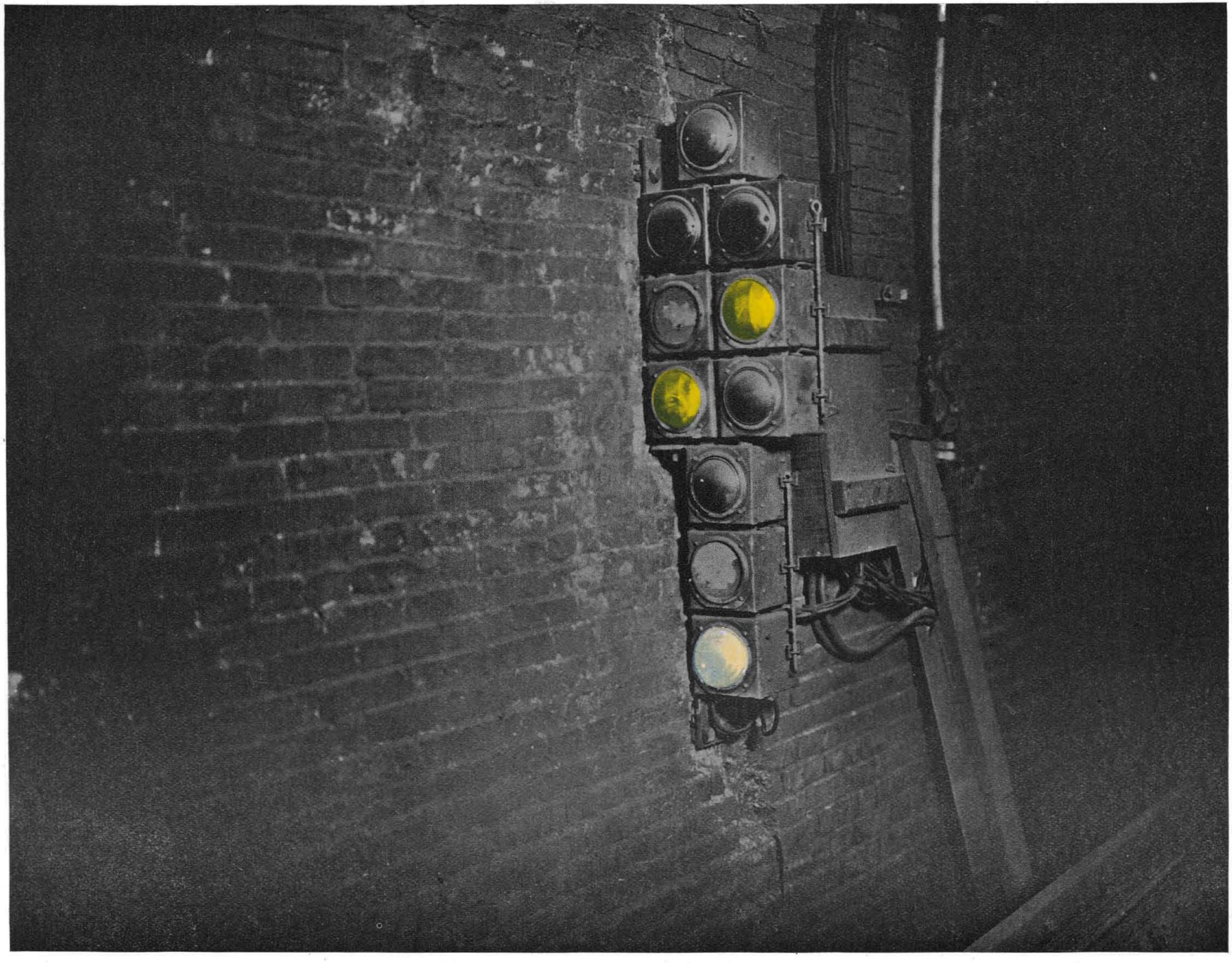


FIG. 6

FIG. 7

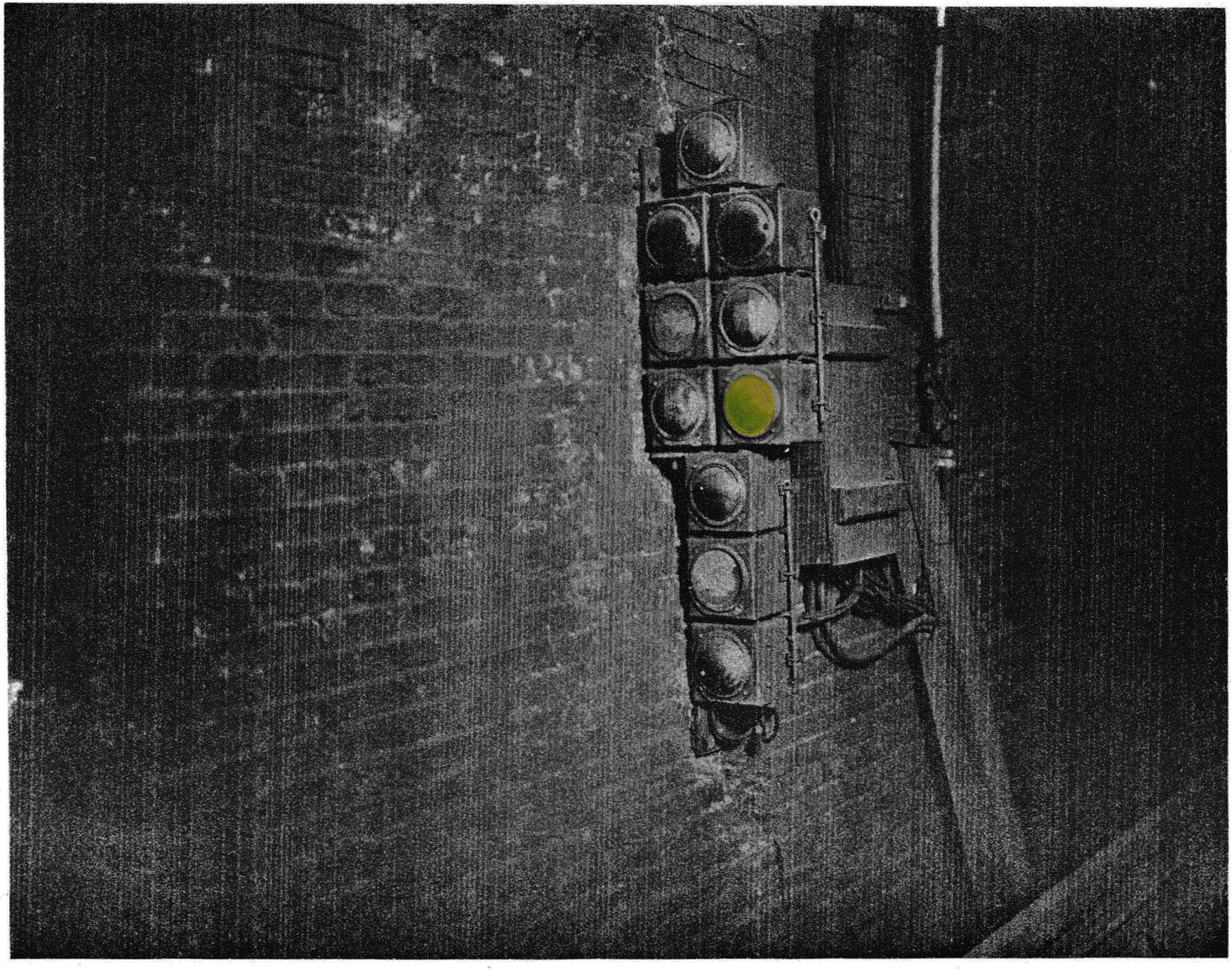
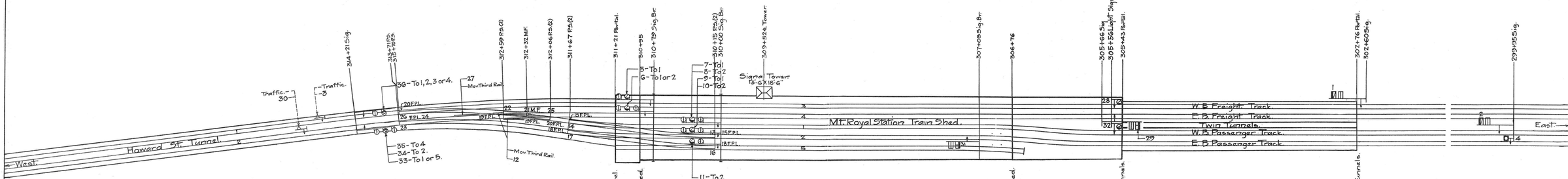
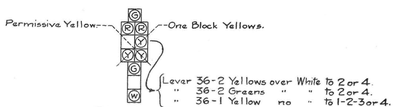
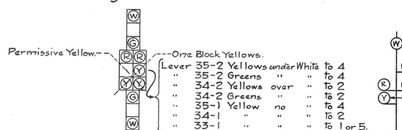


FIG. 8



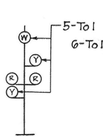


Sig. No. 36.

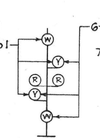


Sig. No. 33-34-35.

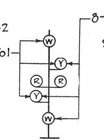
Machine (Standard "A")
2 Levers for 2 Electric Rails.
20 " " 19 Signals & 2 Traffic
9 " " 10 Switches & 2 Mov. Frogs.
" " 9 F.P. Locks.
36 Working Levers
0 Spare Levers.
36 Lever Frame.



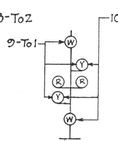
Sig. No. 5



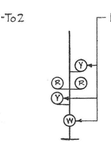
Sig. No. 6.



Sig. No. 7-8.



Sig. No. 9-10



Sig. No. 11.

Sig. No. 28.

Sig. No. 32.

THE BALTIMORE AND OHIO SYSTEM
Baltimore Division.

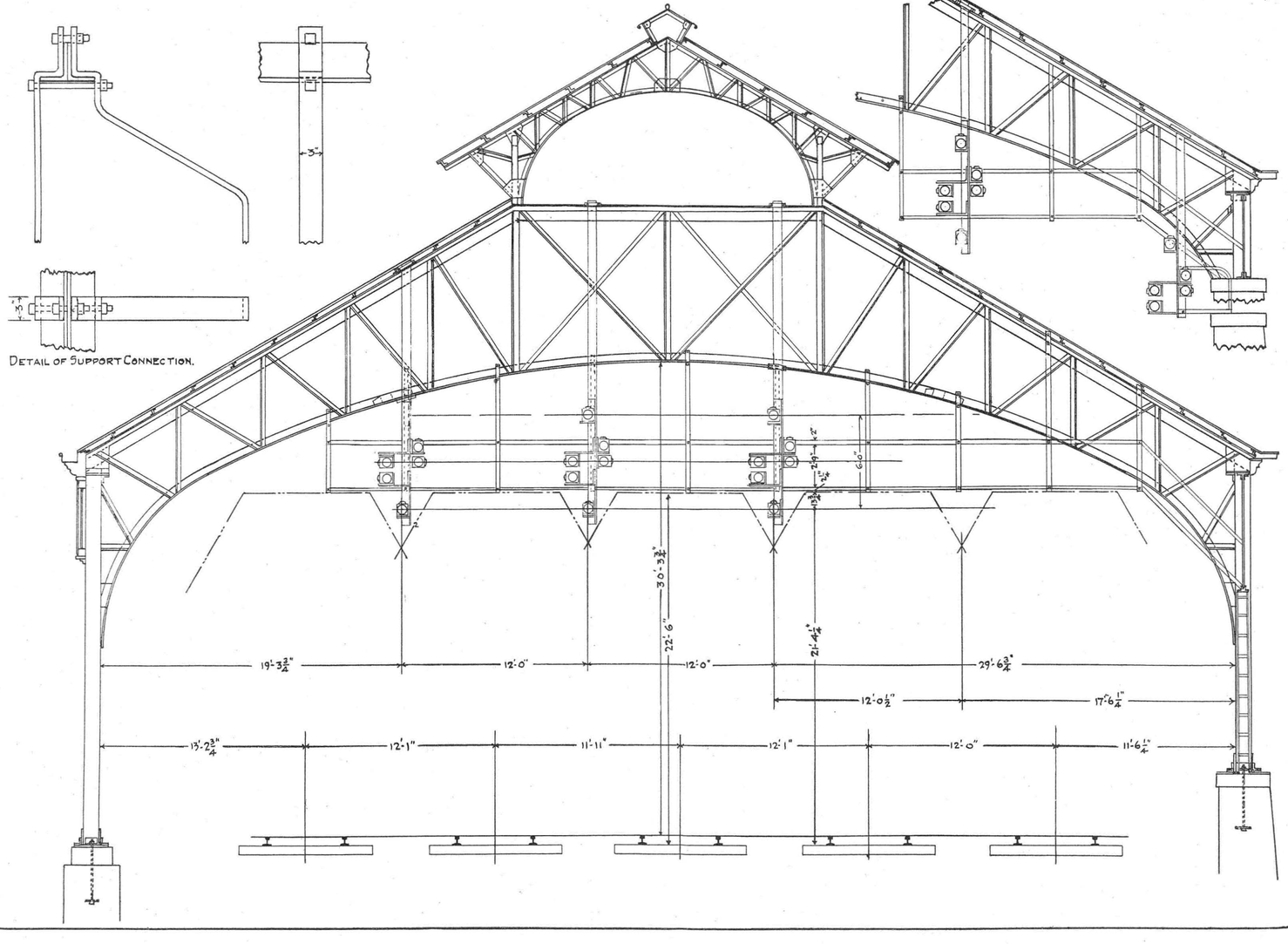
INTERLOCKING PLAN
MOUNT ROYAL STATION
BALTIMORE, MD.

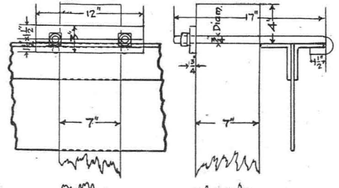
Scale:- 1 In = 50 ft. April 20, 1920.
Office of Signal Engineer.
Baltimore, Md.

File:- 305-1-C.

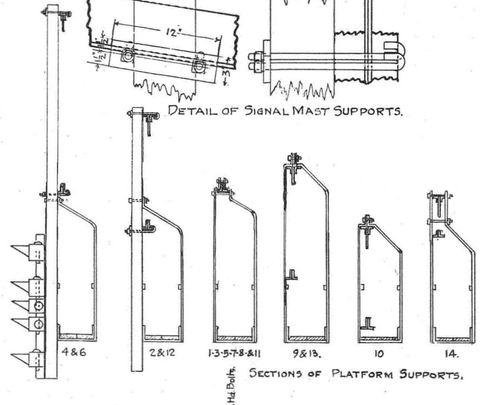
Revisions.	
1920	First Installation. 36 Lever Std A mech. Installed. - - - 1896.
April 1-16, 1920	Oct. 14, 1919. 1st-Detector bars removed and plant re-numbered account of installing detector circuits and 130 lb rail. 2nd-Traffic levers #3 and 30 added. 3rd-Signals #28-33-34-35 and 36 changed from mechanical to light (electric)
April 1, 1921	April 20, 1920. New plan made showing rearrangement of signals. 1st-Subst. Tuting light signals for semaphore 2nd-Installed control manual block Mt Royal to C A Camden.

Designed by
Drawn by
Traced by
Checked by

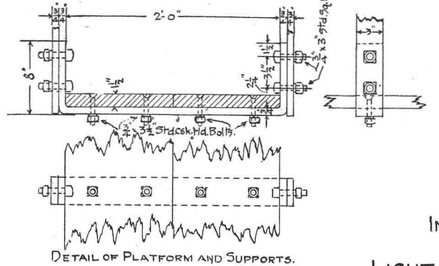




Detail of Signal Mast Supports.



Sections of Platform Supports.



Detail of Platform and Supports.

THE BALTIMORE AND OHIO RAILROAD CO.
Baltimore Division Baltimore Belt R.R.

INTERLOCKING AT MOUNT ROYAL STATION. BALTIMORE, MD.

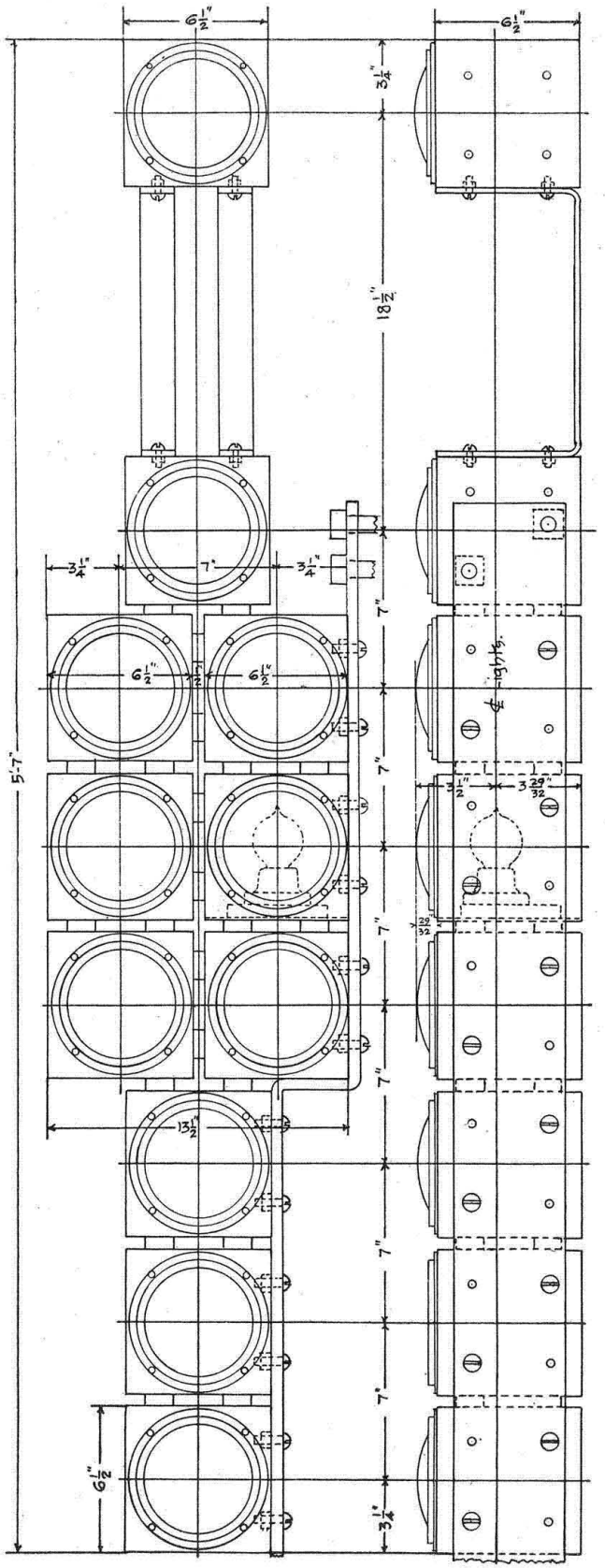
LIGHT SIGNALS, PLATFORMS AND SUPPORTS.

Scales:- ¼ in. and 1½ in. = 1 ft. Oct. 9, 1920.
Office of Signal Engineer.
Baltimore, Md.

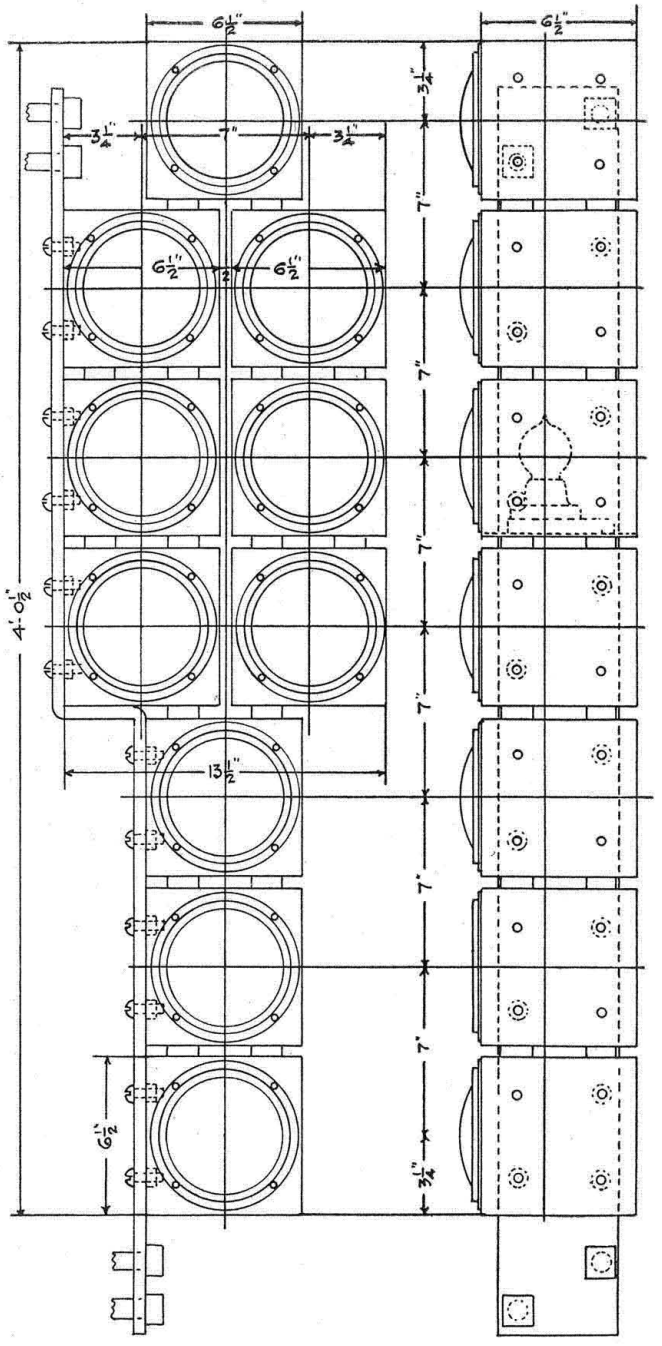
1-Revised, Nov. 24, 1920. Aspects of light signals changed. RMT.	2-Revised July 7, 1921. Aspects of signals, and platform supports changed. RMT.

File:- 305-A-1.

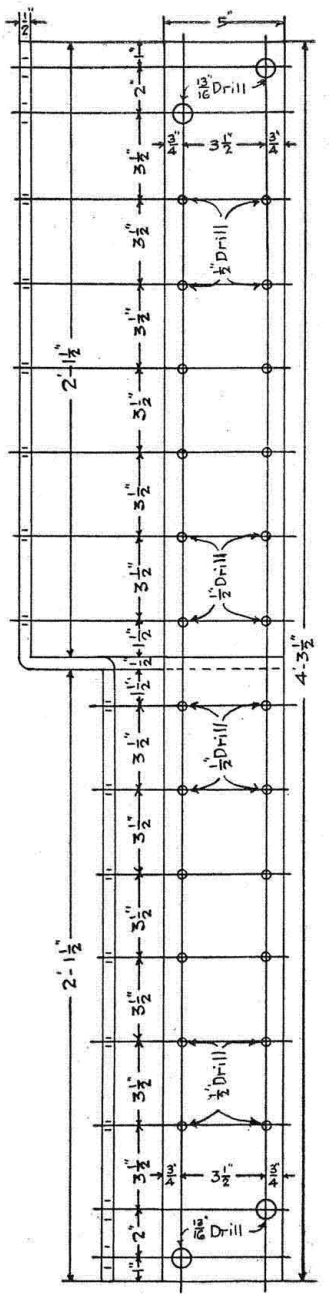
Designed by	R.W. Taylor
Drawn by	"
Traced by	"
Checked by	"



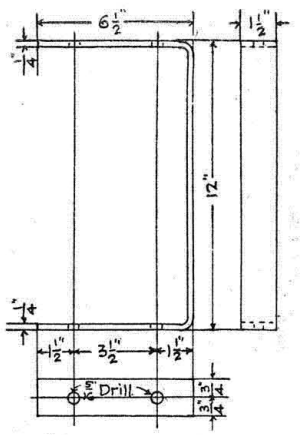
ASSEMBLY OF TUNNEL LIGHT SIGNAL FOR E.B. TRACK-30511.



ASSEMBLY OF TUNNEL LIGHT SIGNAL FOR W.B. TRACK-30512.



SUPPORTING PLATE-30510
WRO'T IRON.



SEPERATOR-30513.
WROT IRON.

1-Revised July 19, 1921.
Signal Aspect changed.
One Signal added.
New plan made
R.H.T.

THE BALTIMORE AND OHIO SYSTEM.
Baltimore Terminal Division.

TUNNEL LIGHT SIGNALS AND SUPPORT.

MT. ROYAL STATION,
BALTIMORE, MD.

Scale:-3in.=1ft. Mar. 9.1921.
Office of Signal Engineer
Baltimore, Md.

File:-305-A-G.
R.W.Taylor

No.	Locking.	Functions.	Remarks.
1	28	1-Home Signal.	
	w 26 X 36		
2	32	1-Home Signal.	
3	36	Traffic Lever.	Electric Lock.
4	31	1-Dwarf Signal.	
5	(20) 26 36 (3)	1-Home Signal.	
6	(19) 21 22 35	1-Home Signal.	
	w 25 X (12)		
	w 25 X 23		
	w 25 X (24) (30)		
	w 25 X (27)		
	w (25) X 36 (3)		
7	14 (19) (21) (22) (25) 36 (3)	½-Home Signal.(Light)	
8	14 (19) (22) 23 (24) 33 (30)	½-Home Signal.(Light)	
9	(13) (19) (21) (25) 36 (3)	½-Home Signal.(Light)	
10	(15) (24) 34 (30)	½-Home Signal.(Light)	
	w 13 X 17		
	w (13) X (19)		
	w (13) X 23		
	w 13 X (23)		
	w (13) X 25		
11	(16) (24) 33 (30)	1-Home Signal.(Light)	
12		Movable Third Rail.	
13	(14)	1-Switch.	
14	(17) (22)	1-Switch.	
15	(W 14 X 13) (W (14) X (13))	2-F.P.Locks.	
16	(17) (23)	1-Switch.	
17		1-Switch.	
18	(W 17 X 16) (W (17) X (16))	2-F.P.Locks.	

No.	Locking.	Functions.	Remarks.
19	(20) (15) (W 21 X 22) (W (21) X (22))	4-F.P.Locks.	
20	(W 25 X 26) (W (25) X (26))	3-F.P.Locks.	
21		2-Movable Frogs.	
22	12 27	2-Switches.	
23	12 27	1-Switch.	
24	23 (23)	1-F.P.Lock.	
	w (23) X (18)		
25	(26)	2-Switches.	
26	12 (23) 27	1-Switch.	
27		Movable Third Rail	
28		1-Dwarf Signal.	
29		1-Home Signal.	Electric Lock.
30	33 34 35	Traffic Lever.	Electric Lock.
31		1-Home Signal.	Electric Lock.
32		1-Dwarf Signal.	
33	(24)	⅓-Home Signal.(Light)	
	(W (23) X (16)) (W 23 X (19) (22) 14 2)		
34	(24) (15) 4	⅓-Home Signal (Light)	
	w 23 X (13)		
	w 23 X (19)		
	W (23) X 17		
	W 23 X (22)		
35	(12) (19) 21 22 23 (24) (27)	⅓-Home Signal (Light.)	

No.	Locking.	Functions.	Remarks.
36	(20)	1-Home Signal.(Light)	
	w 14 (22) (25) X 2		
	w (14) (22) (25) X 4 (13)		
	w (25) X (19)		
	w (22) (25) X (21)		
	w (26) X (25)		

THE BALTIMORE AND OHIO SYSTEM

Lines East Baltimore Division

LOCKING SHEET

MT. ROYAL STATION

BALTIMORE, MD.

Office of Signal Engineer

Baltimore, Md.

Oct. 18, 1919.

File:- 305-2-A.

Revisions.

Oct. 18, 1919. New locking sheet made covering revision of Oct. 14, 1919 ground plan File: 305-1-B.

April 16, 1920. Jan. 27, 1920 Locking revised covering revision of Jan. 27, 1920 ground plan File:- 305-1-B.

Feb. 27, 1920. 23 X 12-27 added.

Apr. 1, 1921. Dec. 9, 1920. Locking revised— covering ground plan dated April 20, 1920. File:- 305-1-C.

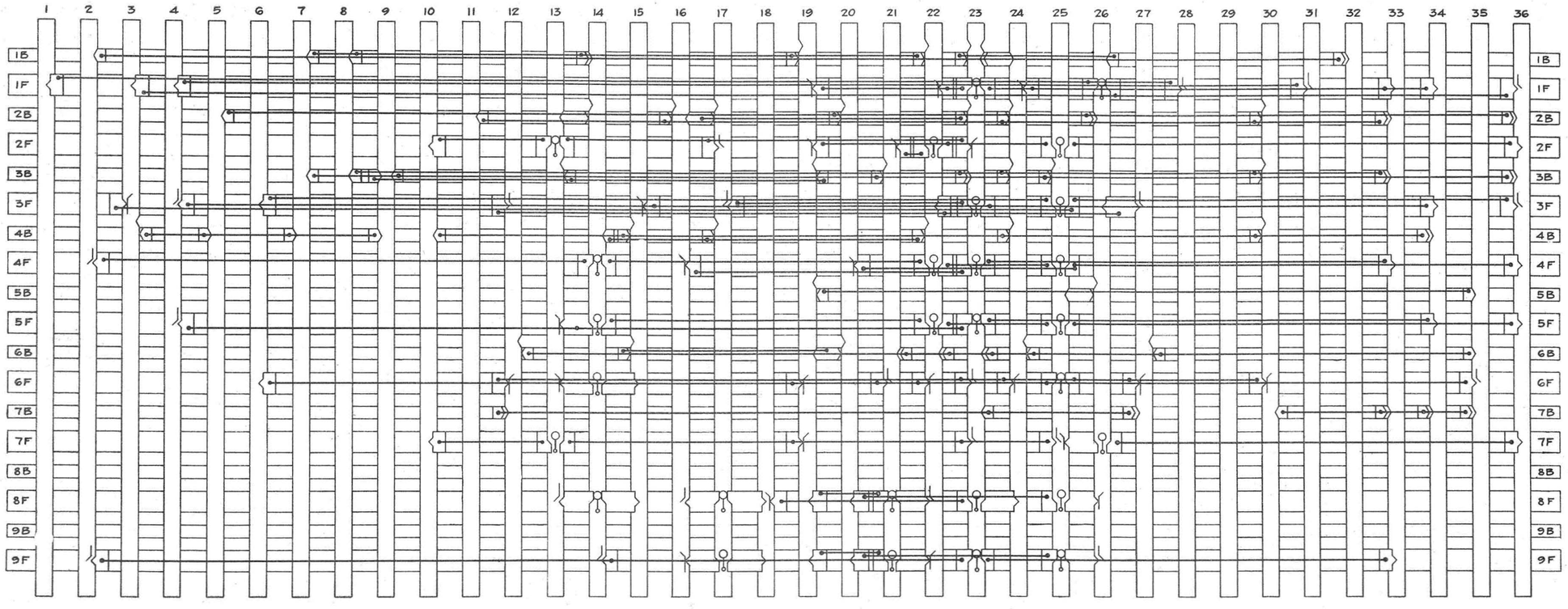
Published

Designed by

Drawn by Wm. A. Covey.

Traced by Wm. A. Covey.

Checked by



THE BALTIMORE AND OHIO SYSTEM

Baltimore Division.

DOG CHART

MT. ROYAL STATION

BALTIMORE, MD.

Office of Signal Engineer

Baltimore, Md.

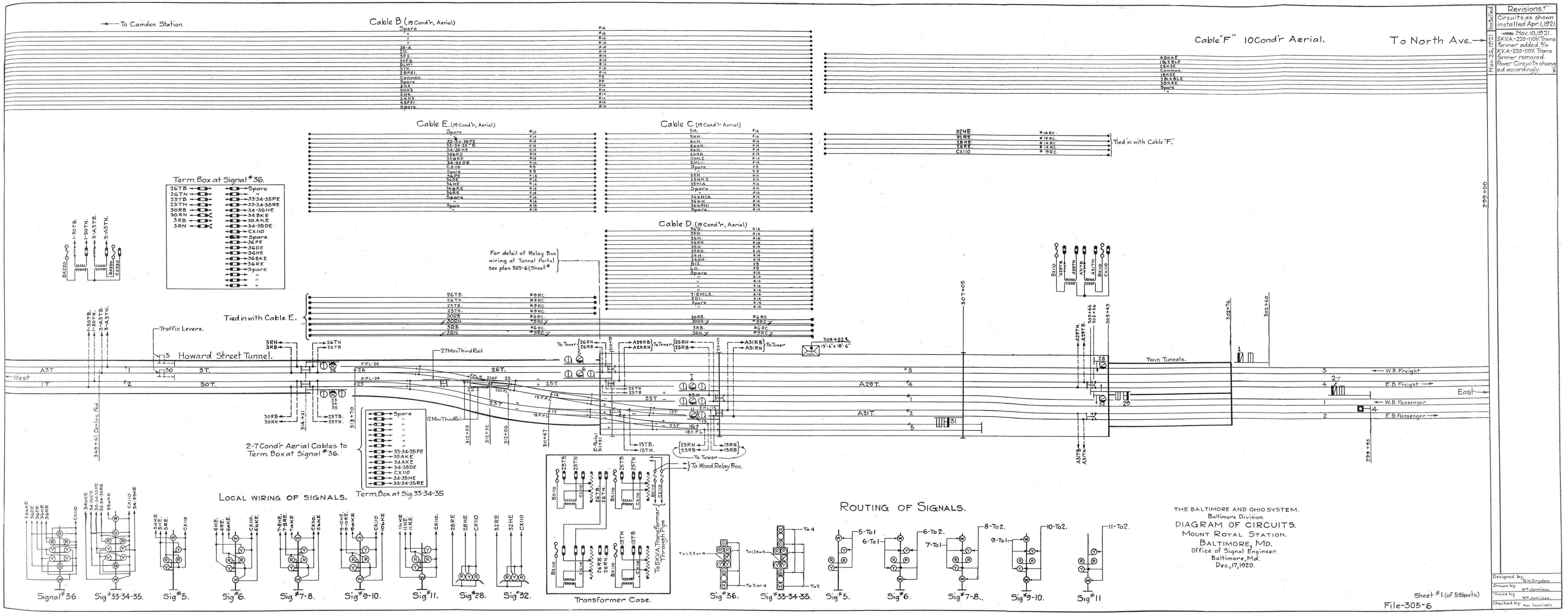
May 12, 1920.

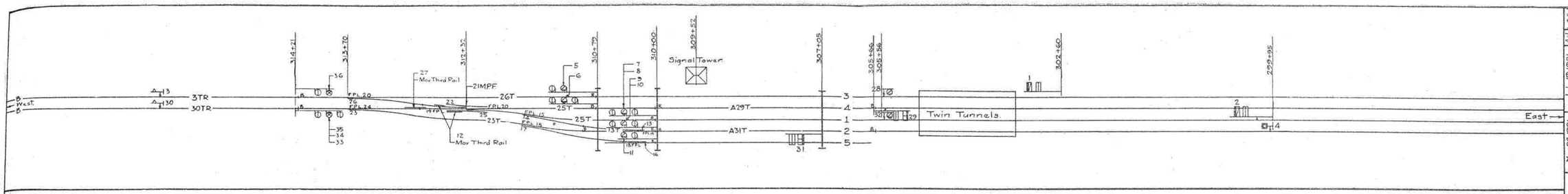
Revisions.
May 12, 1920. New record dog chart made covering revisions of — Oct. 18, 1919, Jan. 27, 1920 and Feb. 27, 1920 on locking sheet — File:- 305-2-A
Dec. 9, 1920. Locking revised covering ground plan dated April 20, 1920 File:-305-1-C.

Apr. 1, 1921. Apr. 16, 1920. Installed

Designed by
Drawn by S.E.Taylor
Traced by S.E.Taylor
Checked by

File:-305-4-A


Revisions.
Installed
Circuits as shown installed Apr. 1, 1921.
Nov. 26, 1921
Nov. 10, 1921. 5 KV.A.-220-110 V. Transformer added. 5/10 KV.A.-220-110 V. Transformer removed. Power Circuits changed accordingly.
To Camden Station
Cable B (19 Cond'r, Aerial)
Cable "F" 10 Cond'r Aerial.
To North Ave.
Cable E. (19 Cond'r, Aerial)
Cable C (19 Cond'r Aerial)
Tied in with Cable "F".
Term. Box at Signal #36.
Cable D (19 Cond'r, Aerial)
For detail of Relay Box wiring at Tunnel Portal see plan 305-6 (Sheet #
Tied in with Cable E.
Traffic Levers.
Howard Street Tunnel.
West
Twin Tunnels.
W.B. Freight
E.B. Freight
East
W.B. Passenger
E.B. Passenger
To Tower
To Wood Relay Box.
2-7 Cond'r Aerial Cables to Term. Box at Signal #36.
Term. Box at Sig. 33-34-35
Transformer Case.
To 5 KV.A. Transformer Through Pipe
Local wiring of signals.
Signal #36
Sig #33-34-35.
Sig #5.
Sig #6.
Sig #7-8.
Sig #9-10.
Sig #11.
Sig #28.
Sig #32.
Routing of Signals.
Sig #36.
Sig #33-34-35.
Sig #5.
Sig #6.
Sig #7-8.
Sig #9-10.
Sig #11
THE BALTIMORE AND OHIO SYSTEM.
Baltimore Division.
DIAGRAM OF CIRCUITS.
MOUNT ROYAL STATION.
BALTIMORE, MD.
Office of Signal Engineer.
Baltimore, Md.
Dec. 17, 1920.
Sheet #1 (of 5 Sheets)
File-305-6
Designed by G.H. Dryden
Drawn by W. Jennison
Traced by W. Jennison
Checked by Wm. Jennison

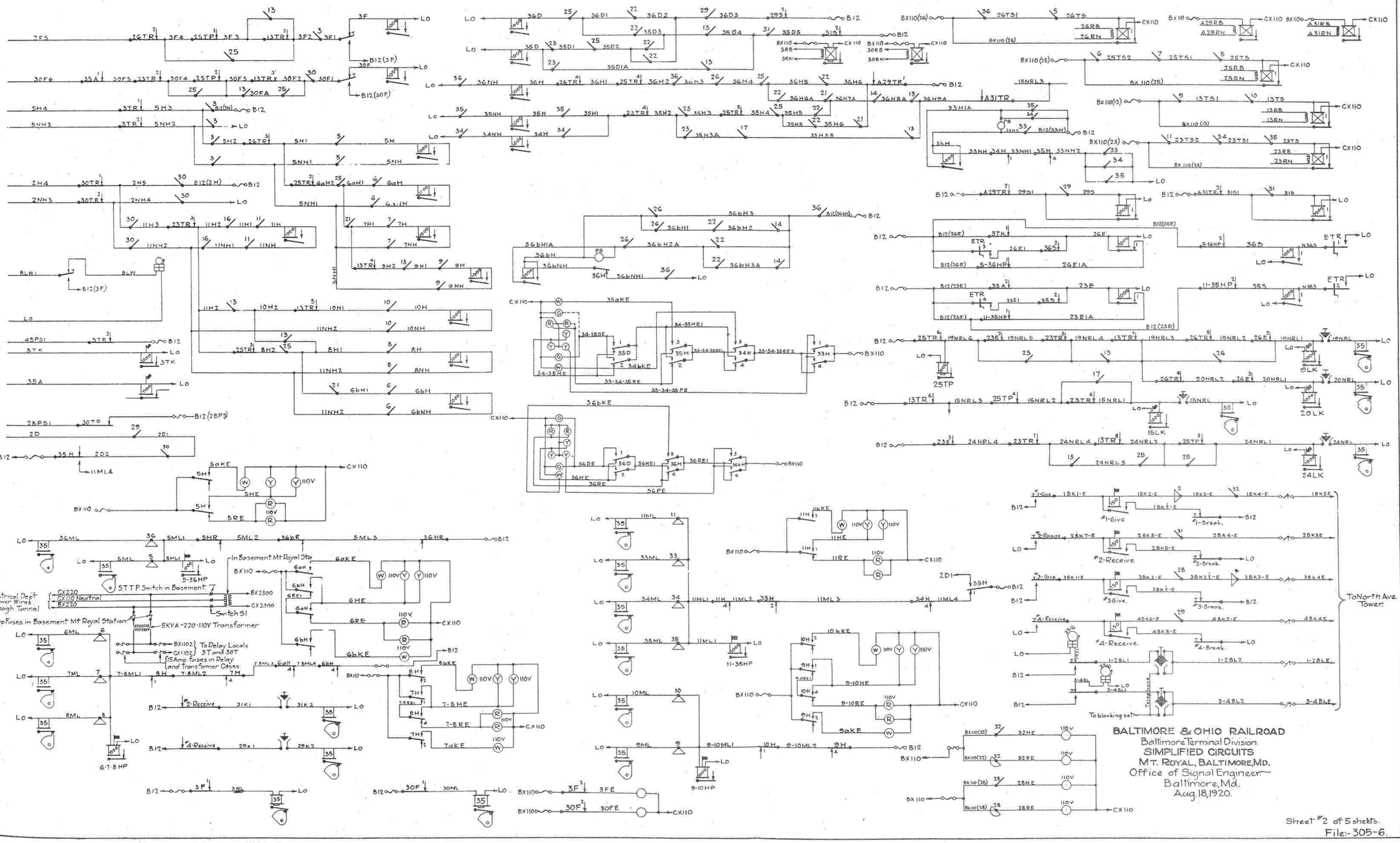


Revisions.

Circuits as shown installed April, 1921.

July 19, 1921. 220-110V Transformer added Mt. Royal Tower & West End Tunnel for operation Relay Locals Tunnel Track Circuits. Installed:- July 19, 1921.

Nov. 10, 1921. 5KV.A-220-110V. Transformer added. 9KV.A. 220-110V Transformer removed. Power Circuits changed accordingly. JS



BALTIMORE & OHIO RAILROAD

Baltimore Terminal Division.

SIMPLIFIED CIRCUITS

MT. ROYAL, BALTIMORE, MD.

Office of Signal Engineer

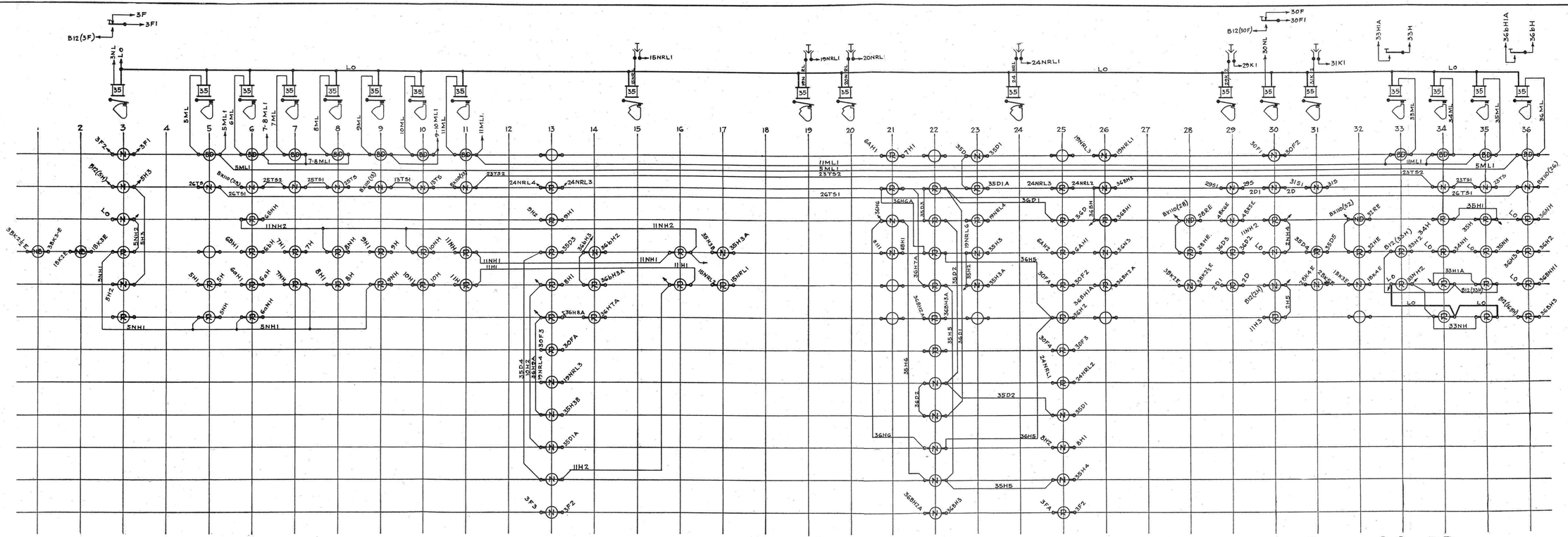
Baltimore, Md.

Aug. 18, 1920.

Designed by G.H.Dryden.
Drawn by Wm. A Covey
Traced by
Checked by G.H.Dryden.

Sheet #2 of 5 sheets.

File:- 305-6.

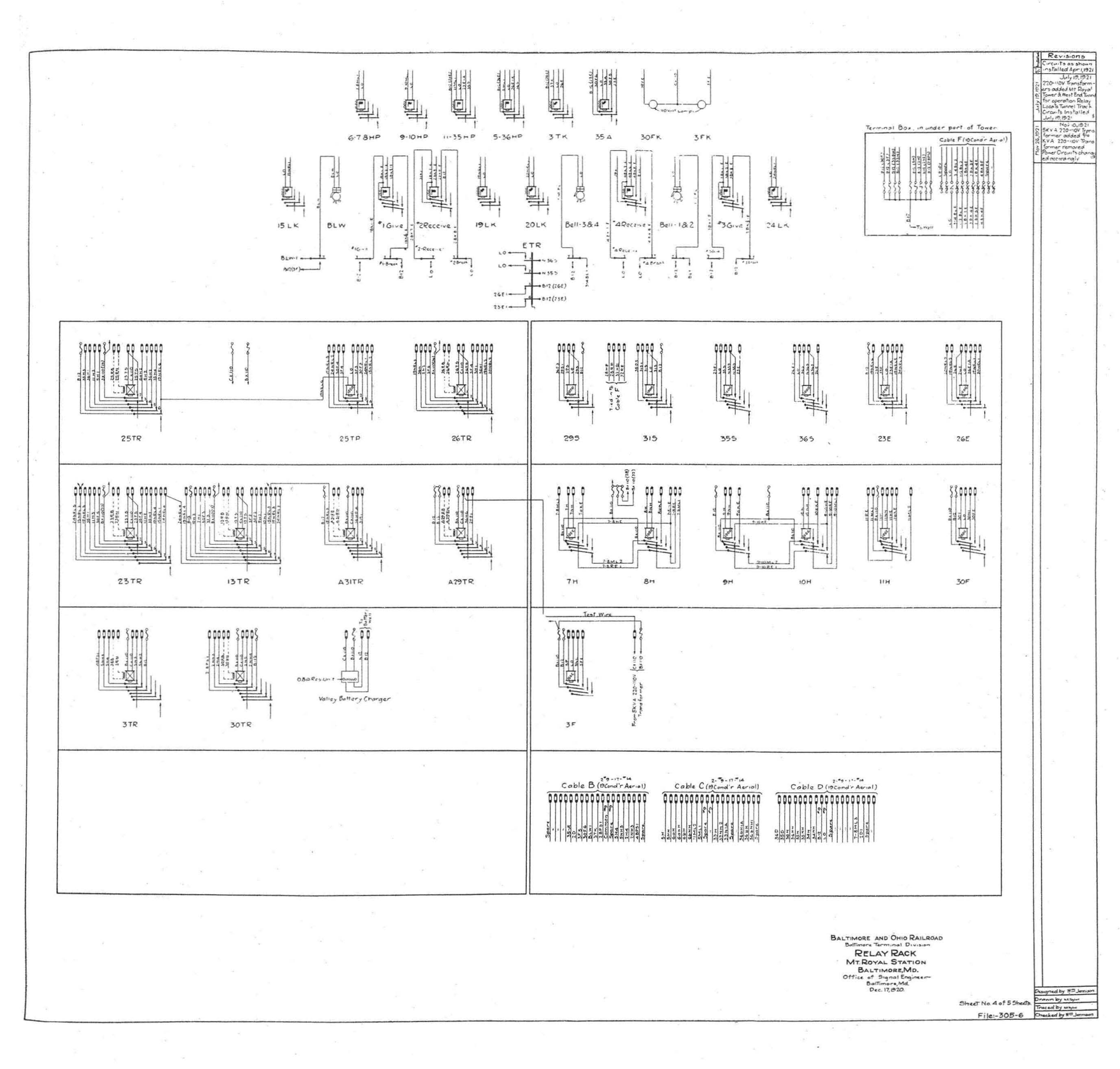


BALTIMORE & OHIO R.R.
Baltimore Terminal Division.
SPRING COMBINATION
MT. ROYAL STATION
BALTIMORE, MD.
Office of Signal Engineer
Baltimore, Md.
Dec. 9, 1920.

Sheet #3 of 55 Sheets.

Revisions.
Circuits as shown Installed April 1, 1921

Designed By	
Drawn By	
Traced By	
Checked By	Wm. Jennison
File No.	305-6.



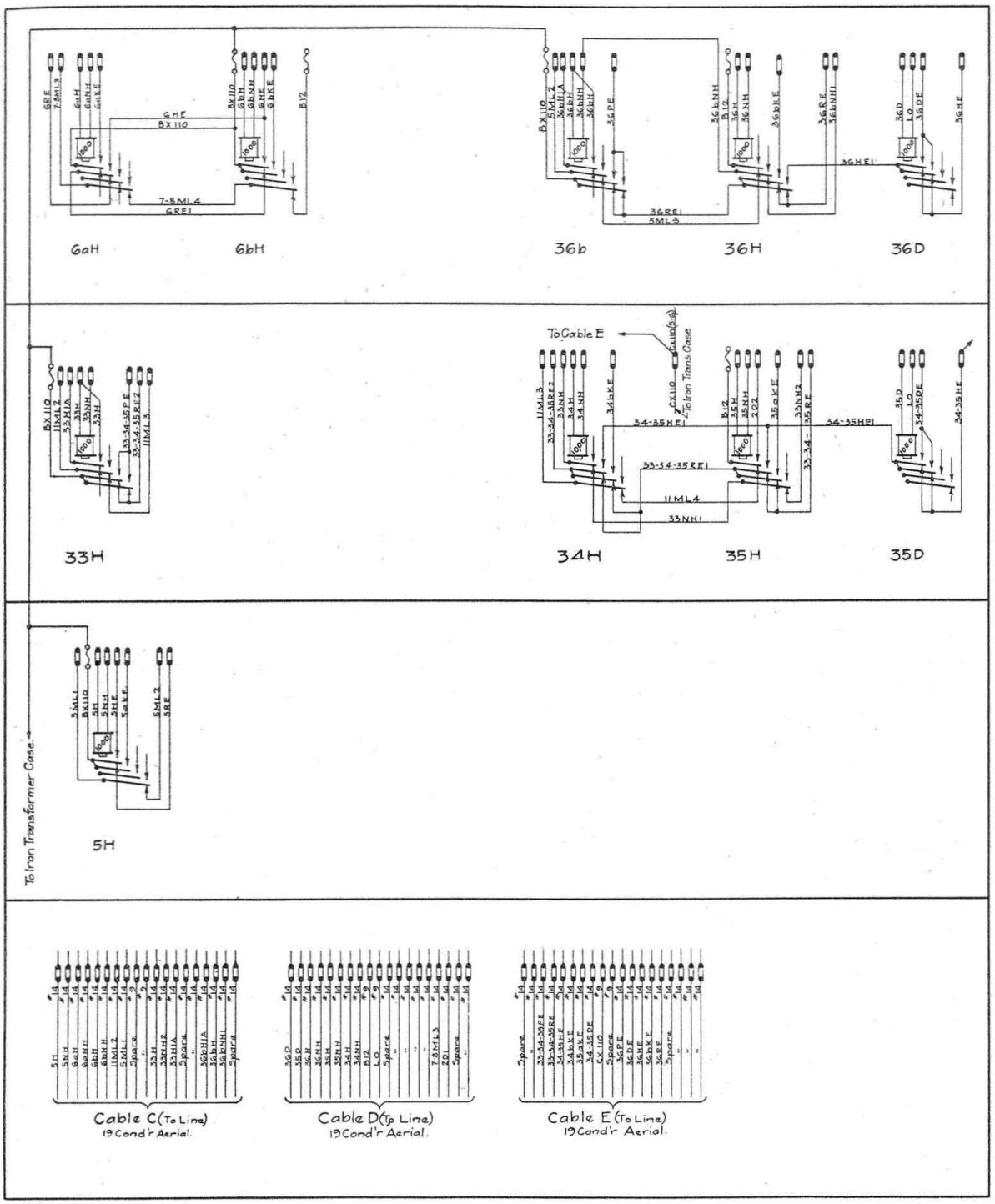
Revisions
Circuits as shown installed Apr. 1, 1921
July 19, 1921 220-110V Transformers added Mt Royal Tower & West End Tunnel for operation Relay Local & Tunnel Track Circuits installed July 19, 1921
Nov. 10, 1921 5KVA 220-110V Transformer added 5/6 KVA 220-110V Transformer removed Power Circuits changed accordingly

Designed by W.D. Jamison
Drawn by [illegible]
Traced by [illegible]
Checked by W.D. Jamison

BALTIMORE AND OHIO RAILROAD
Baltimore Terminal Division
RELAY RACK
MT. ROYAL STATION
BALTIMORE, MD.
Office of Signal Engineer
Baltimore, Md.
Dec. 17, 1920.

Sheet No. 4 of 5 Sheets

File:-305-6



Revisions.

Nov. 26, 1921. Installed. Circuits as shown installed Apr. 1, 1921.

Nov. 10, 1921. 5 K.V.A 220-110 V. Transformer added. 9½ K.V.A. 220-110 V. Transformer removed. Power Circuits changed accordingly. S

BALTIMORE AND OHIO RAILROAD
Baltimore Division.

RELAY BOX AT SIGNAL No. 6.

MT. ROYAL STATION
BALTIMORE, MD.
Office of Signal Engineer
Baltimore, Md.
Dec. 20, 1920

Designed by Wm. Jennison
Drawn by E.A. Taylor
Traced by E.A. Taylor
Checked by Wm. Jennison

Sheet #5 of 55 Sheets.

File:- 305-6

THE BALTIMORE AND OHIO RAILROAD COMPANY.
THE BALTIMORE AND OHIO SOUTHWESTERN RAILROAD COMPANY.

STANDARD BELL CODE.

1···DISPLAY STOP SIGNAL.
1-3···I UNDERSTAND.
1-7···DISPLAY STOP SIGNAL, TRAIN FOLLOWING.
2···BLOCK CLEAR.
3···BLOCK WANTED FOR TRAIN OTHER THAN PASSENGER.
3-6···BLOCK WANTED FOR PASSENGER TRAIN.
4···TRAIN OTHER THAN PASSENGER HAS ENTERED BLOCK.
4-6···PASSENGER TRAIN HAS ENTERED BLOCK.
5···BLOCK IS NOT CLEAR OF TRAIN OTHER THAN PASSENGER.
5-6···BLOCK IS NOT CLEAR OF PASSENGER TRAIN.
7···TRAIN FOLLOWING.
8···OPENING BLOCK STATION. ANSWER BY RECORD OF TRAINS IN THE EXTENDED BLOCK.
10···CLOSING BLOCK STATION. ANSWER BY 1-3.
3-3···UNLOCK.
3-3-3···ANSWER TELEPHONE.

Office of Signal Engineer.
Baltimore, Md.
Aug. 31, 1911.
mcf

File: 191.

FIG. 9

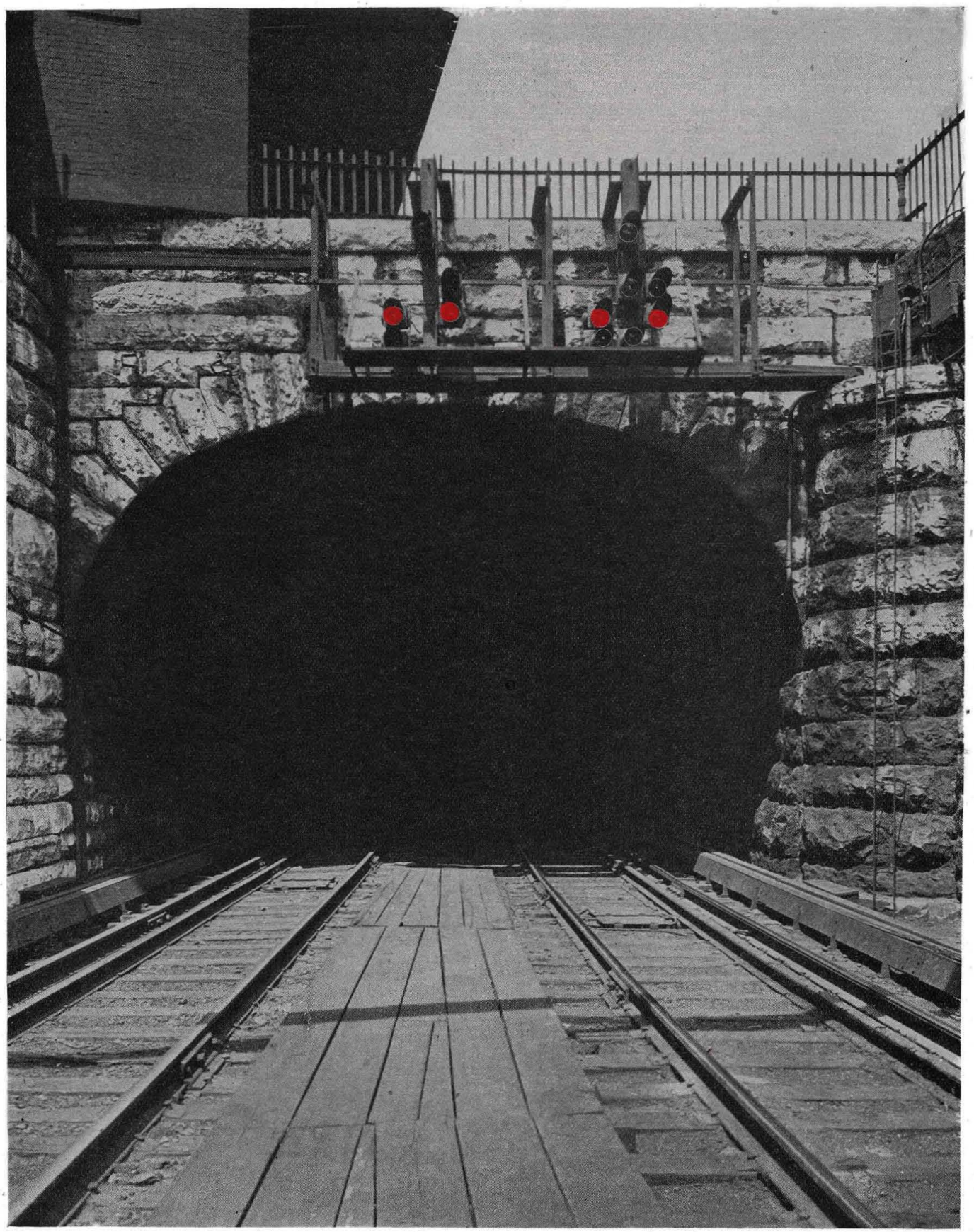


FIG. 10

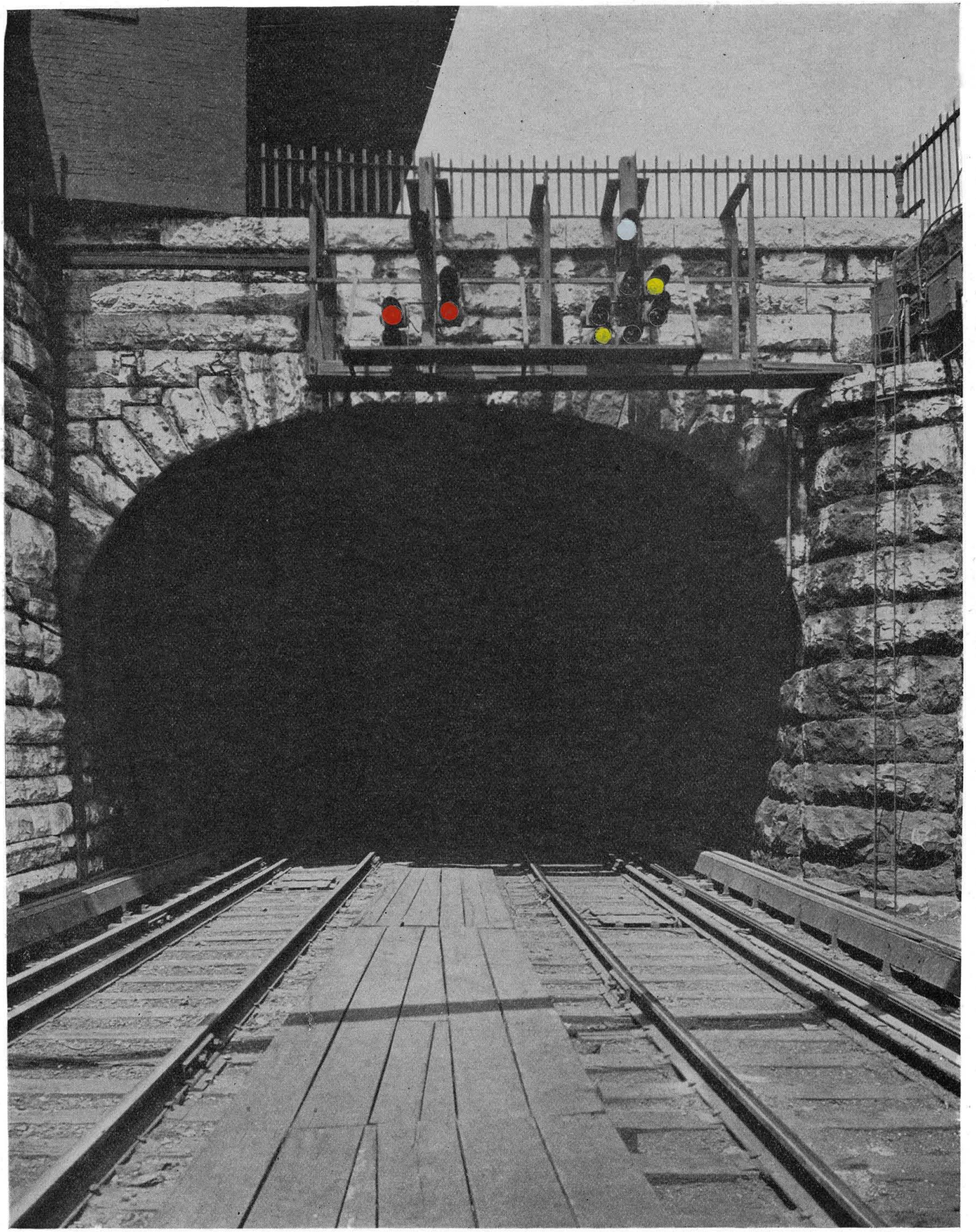


FIG. 11

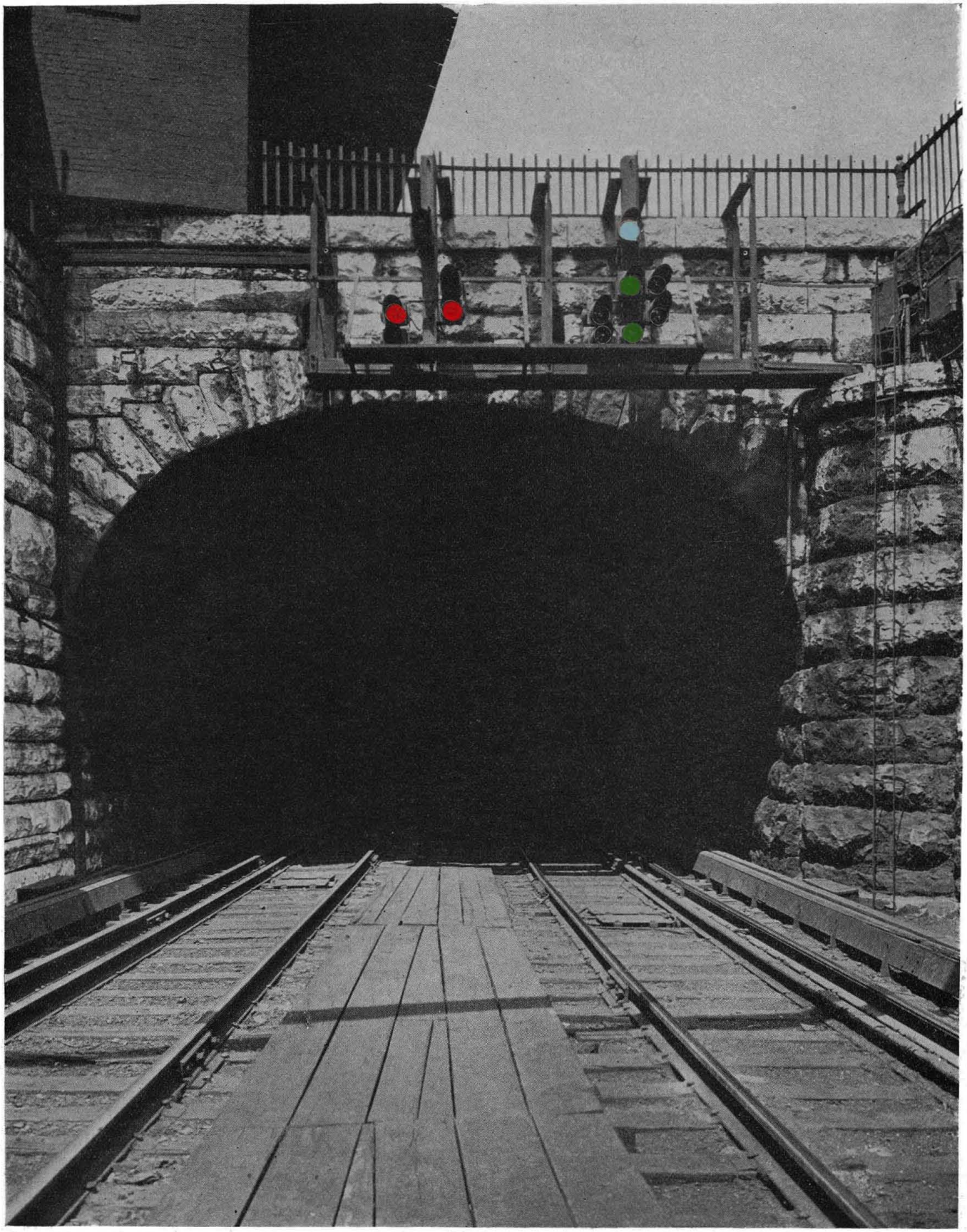
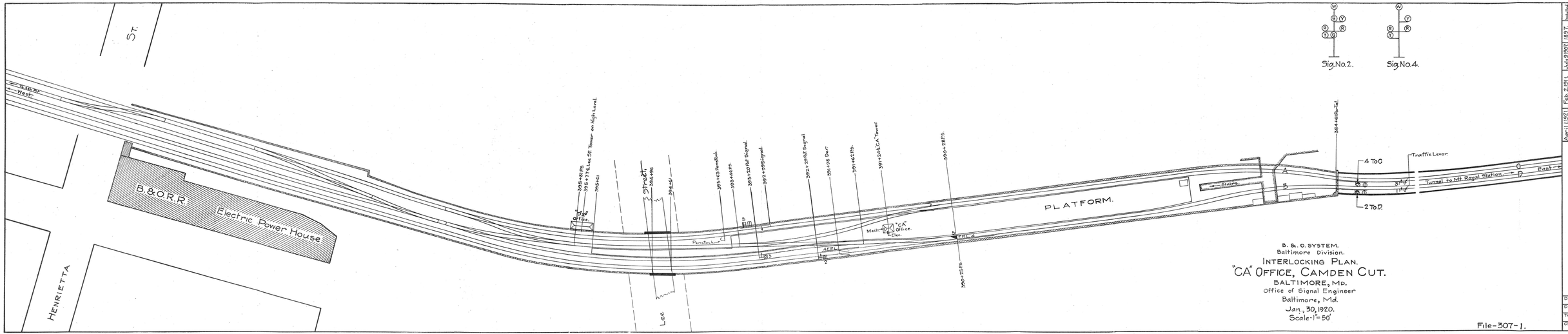


FIG. 12



B. & O. SYSTEM.
Baltimore Division.

INTERLOCKING PLAN.

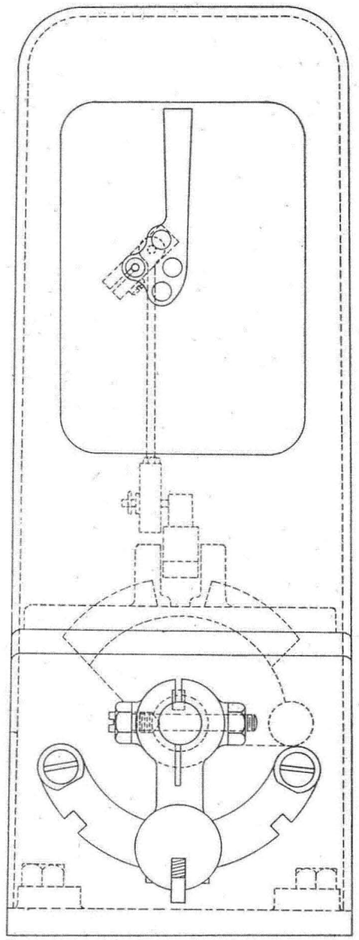
"CA" OFFICE, CAMDEN CUT.

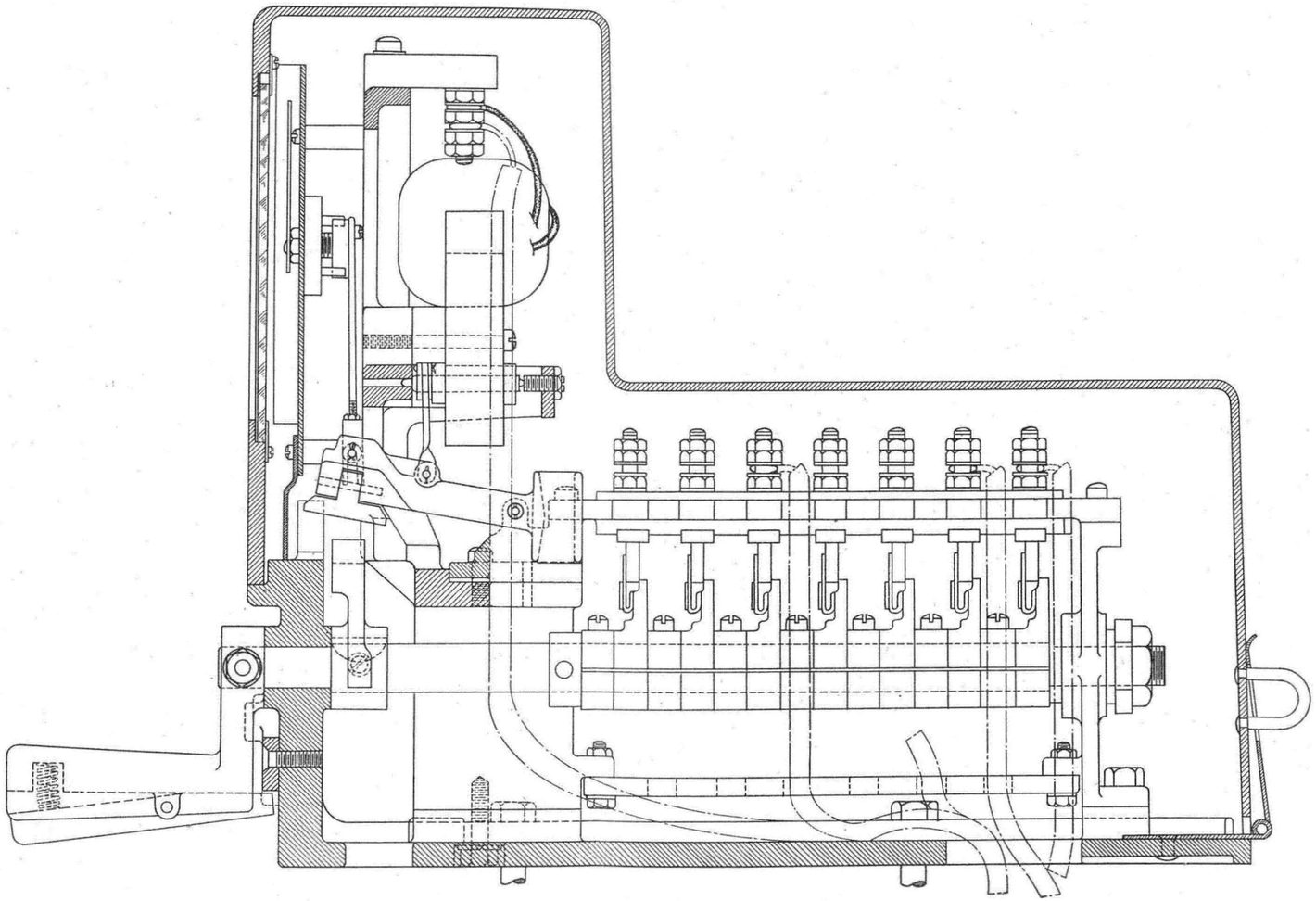
BALTIMORE, MD.
Office of Signal Engineer
Baltimore, Md.
Jan., 30, 1920.
Scale-1"= 50'

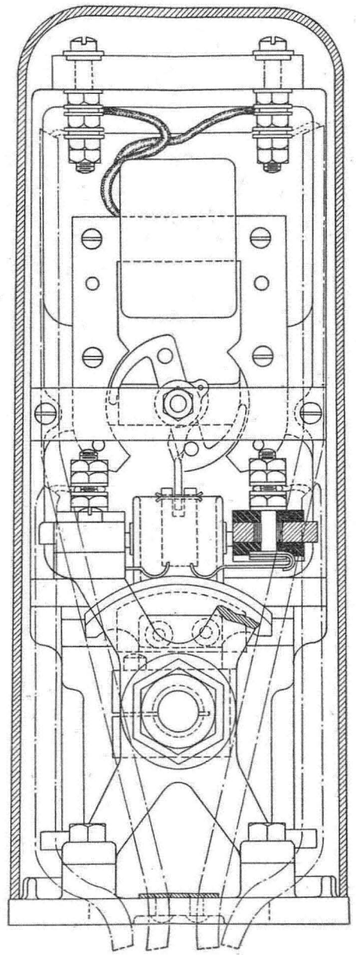
File-307-1.

Revisions.	Initials
First Installation 8 Lever Union Mech. (Ground) Installed - 1897	
Second Installation 8 Lever S&F Mech. Installed July 21 1907 Switch and Derail No. 8 added.	July 1907
Overhead bridge supporting signals No. 2 and 3 removed. Signals "2 & 3 made pot and located on ground. Change made Feb. 2, 1911.	Feb. 2 1911
April 14, 1921 4 Lever Electric Lock Semaphore Indicator machine operating Tunnel Light Signals Installed April 1, 1921.	April 1 1921

Designed by:
Drawn by:
Traced by: [illegible]
Checked by:







BALTIMORE AND OHIO RAILROAD
STYLE "B" (FSCo)

ELECTRICALLY LOCKED SEMAPHORE INDICATOR.

A.C. OPERATION.

Scale Full Size. July 12, 1921.
Office of Signal Engineer
Baltimore, Md.

File:- 152-A

Revisions.

Traced from Federal Signal Company's plan 607-E-9 dated 9-27-1920.

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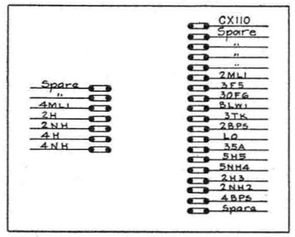
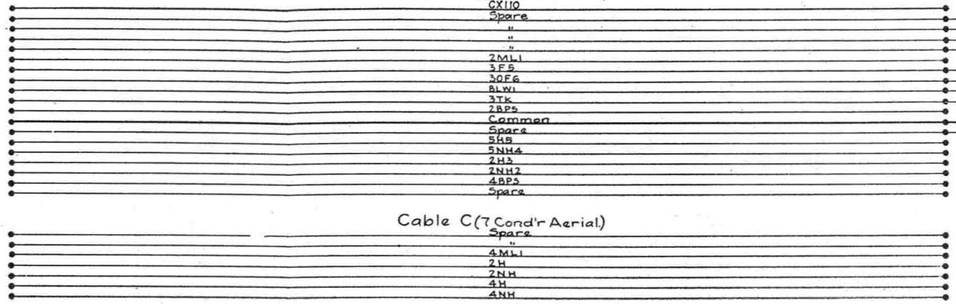
Checked by	

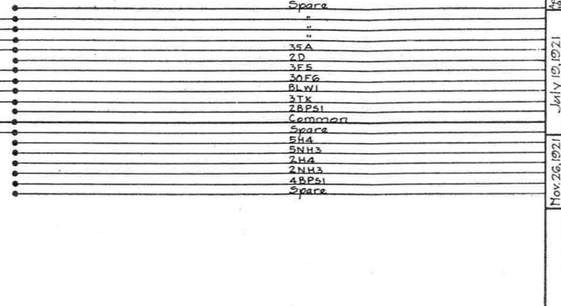
Junc. Box on Fence opp. Tower.



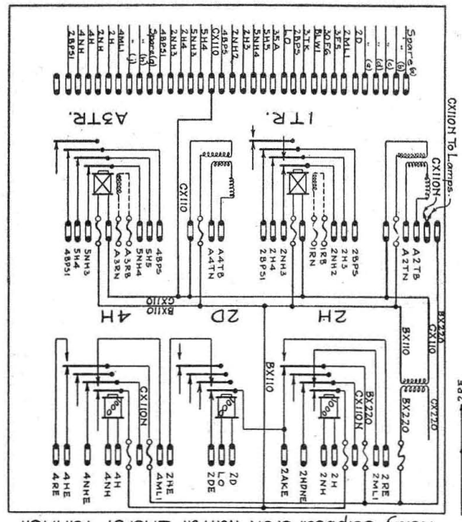
Cable A (19 Cond'r Aerial.)

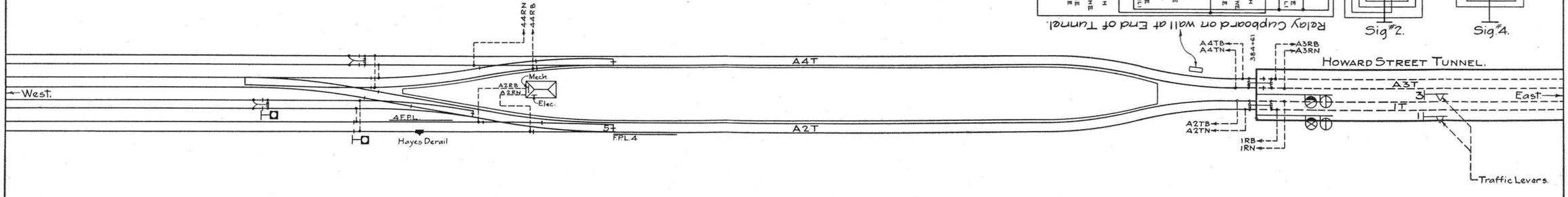


Cable B. (19 Cond'r Aerial)



Cable C (7 Cond'r Aerial.)





BALTIMORE & OHIO RAILROAD.
Baltimore Terminal Division.
DIAGRAM OF CIRCUITS
"CA" OFFICE, CAMDEN CUT, BALTIMORE, MD.
Office of Signal Engineer
Baltimore, Md.
April 13, 1921.

Sheet #1 of 4 Sheets
File:- 307-6

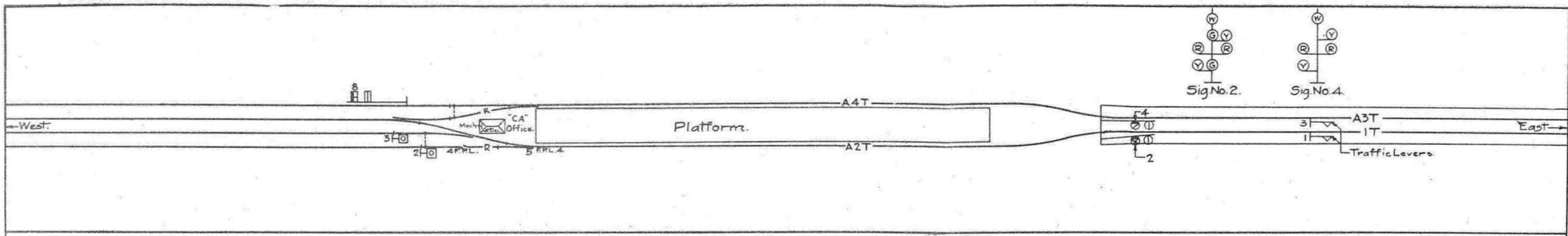
Revisions.

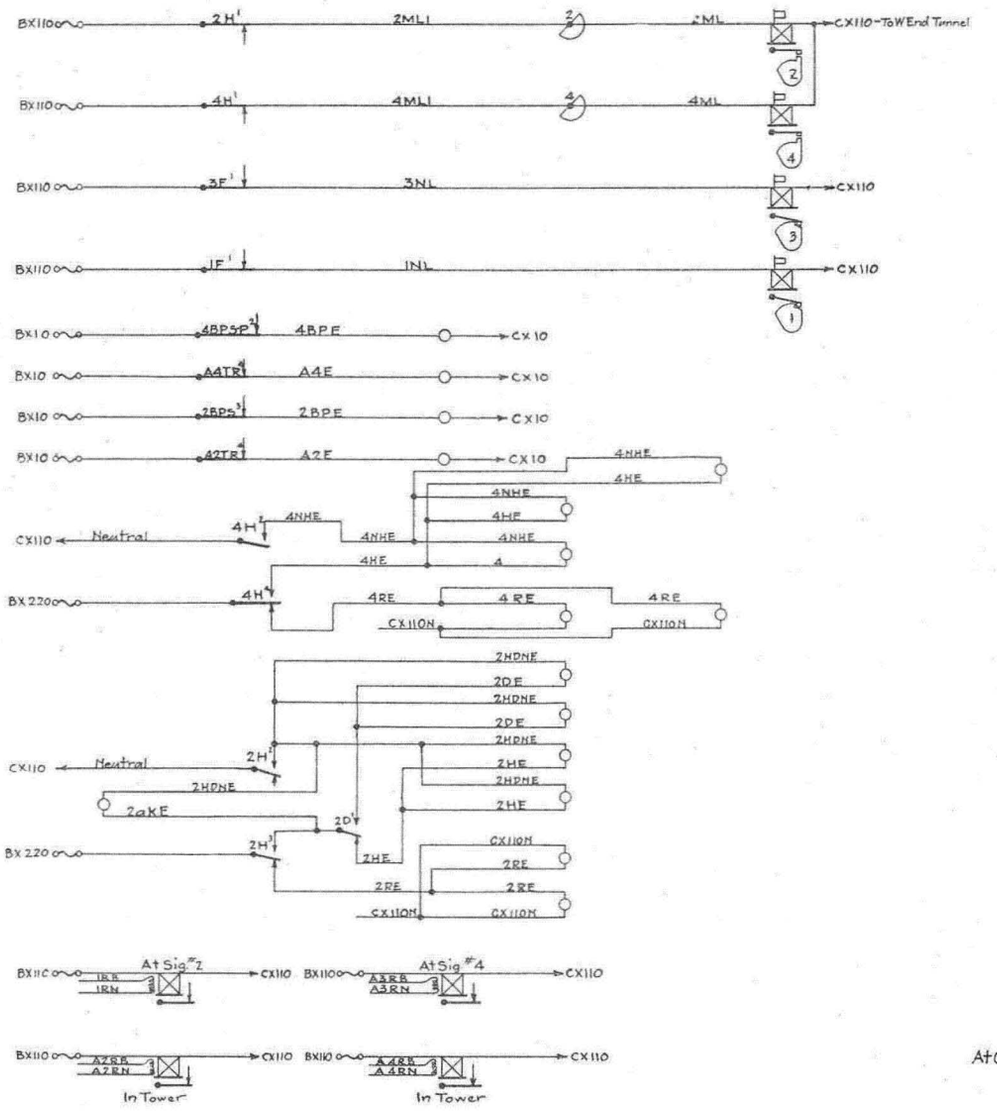
Nov 26, 1921 — Nov. 10, 1921
5/6 K.V.A.-220-110V. Transformers added Power Circuits changed accordingly

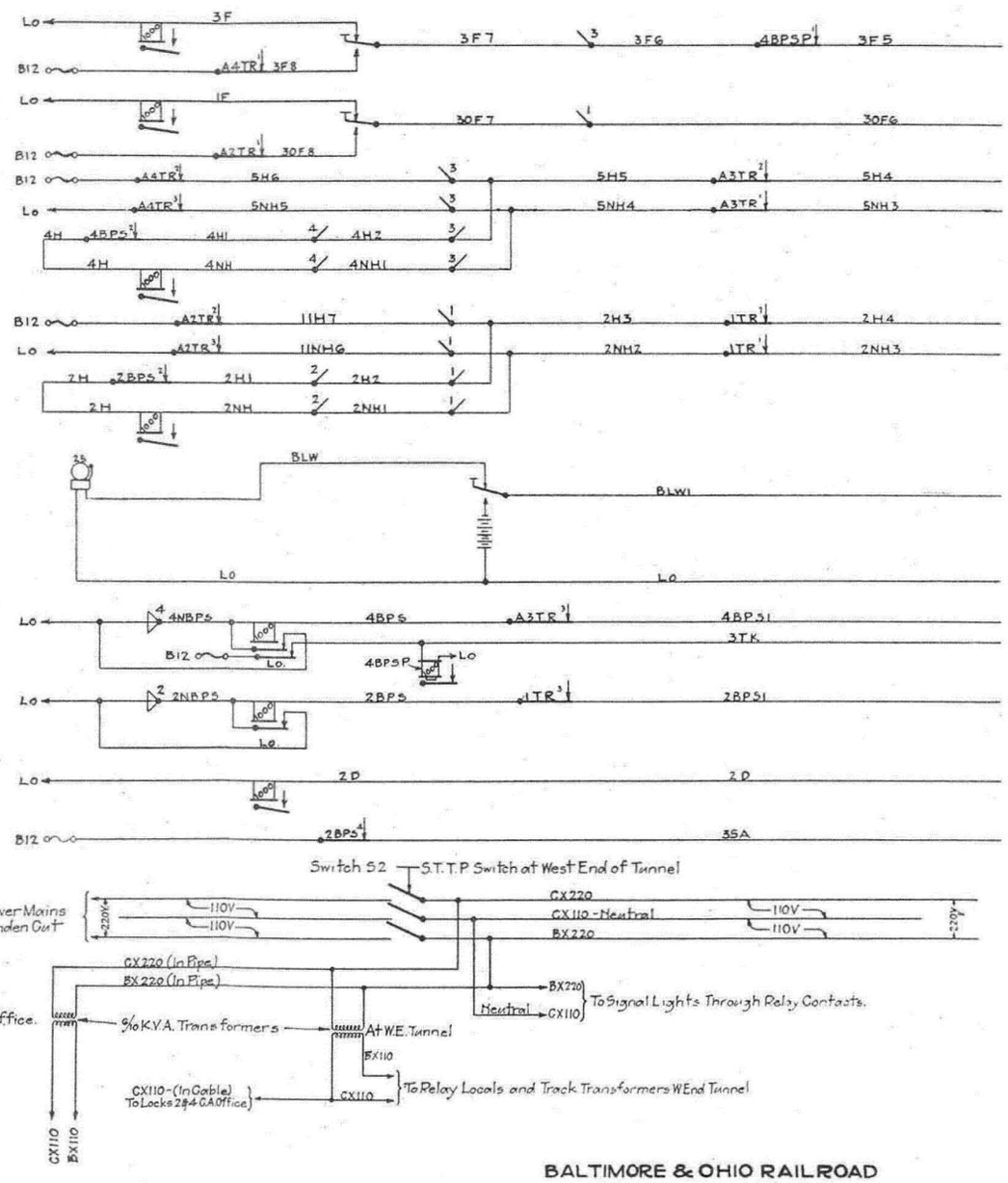
July 19, 1921 — July 19, 1921
220-110V Transformers added Mt Royal Tower & West End Tunnel for operation Relay Locals Tunnel Track Circuits. Installed: July 19, 1921.

Jan 3, 1921 — Installed
April 13, 1921. Circuits as shown Installed: April 1, 1921

Designed by	Wm Jennison
Drawn by	[illegible]
Traced by	[illegible]
Checked by	Wm Jennison.







Note:-
Normal Power source - Mt. Royal
Emergency Power source - Camden
When Mt Royal Power is ineffective
First - Open Switch S1 - in basement Mt. Royal Station.
Second - Close Switch S2 - in Wood Box - West End Howard St Tunnel.

Note:- Lamp, Transformer and Bulb data
Rexlo #18 Style 3, 110-7 volt, 60 cycle, Electric Lamps
Edison Mazda C-G 18½, 8 V., 40 W, 1¼" light centre.

BALTIMORE & OHIO RAILROAD
Baltimore Terminal Division
SIMPLIFIED CIRCUITS
"CA" Office, Camden Cut, Baltimore, Md.
Office of Signal Engineer
Baltimore, Md
Aug. 10, 1920

Revisions.

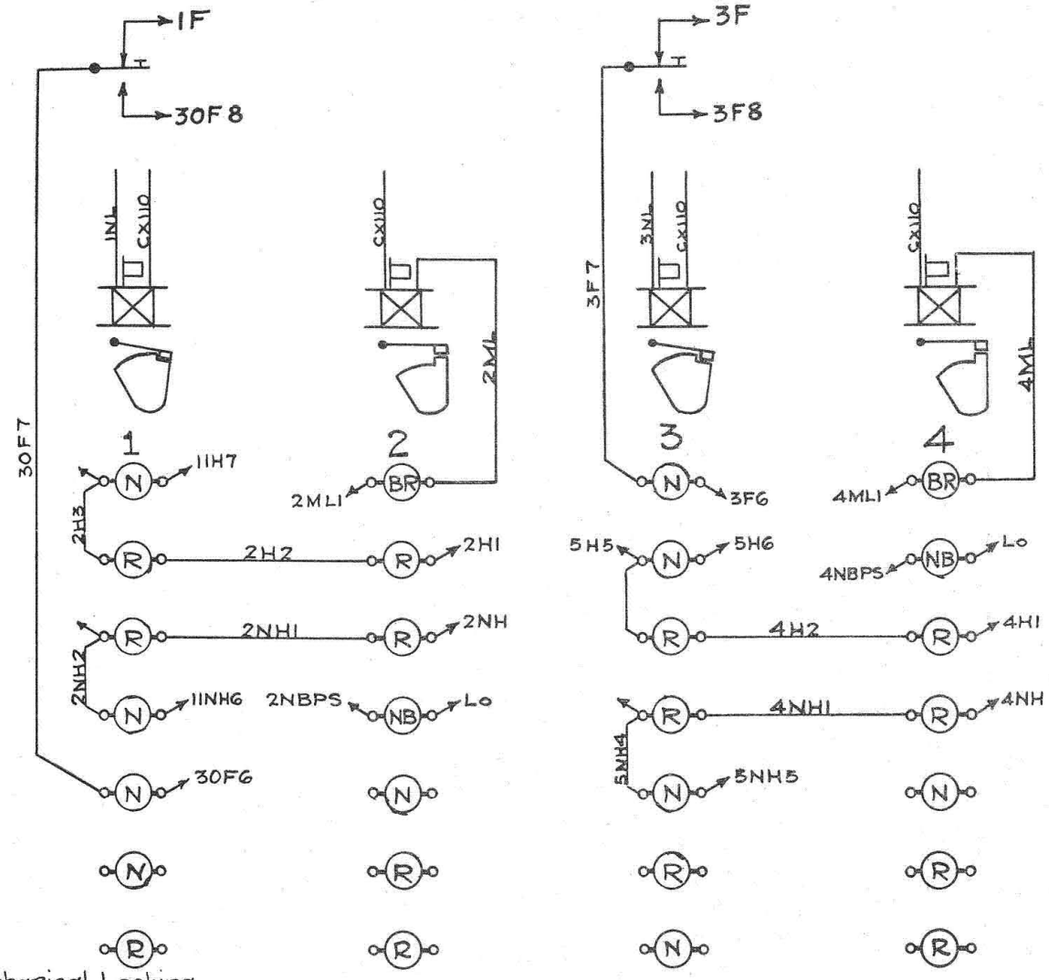
Nov. 1921 Installed.
April 13, 1921.
Circuits as shown Installed:- April 1, 1921.

July 19, 1921.
220-110V Transformers added Mt Royal Tower & West End Tunnel for operation Relay Locals Tunnel Track Circuits Installed: July 19, 1921.

Nov. 26, 1921.
5% K.V.A. 220-110V. Transformers added. Power Circuits changed accordingly.

Designed by A.H. Dryden.
Drawn by Wm. A. Corey.
Traced by
Checked by A.H. Dryden.

Sh. 2 of 4 Sheets
File:- 307-6



Mechanical Locking

1- No locking — 110 volt, 60 cycle. Normal traffic lock. Blade 45° U.Q. when energized.
2- Locks (1) 110 volt, 60 cycle. Signal indication lock. Blade 45° U.Q. when deenergized
3- No locking - 110 volt, 60 cycle. Normal traffic lock. Blade 45° U.Q. when energized.
4- Locks (3) 110 volt, 60 cycle. Signal indication lock. Blade 45° U.Q. when de-energized.
All levers operate in 2 positions only.

BALTIMORE & OHIO RAILROAD

Baltimore Terminal Division
Diagram of Circuit Controller and Locks
Electrically Locked Semaphore Indicator Machine
C. A. Office, CAMDEN CUT, BALTIMORE. MD.
Office of Signal Engineer
Baltimore, Md.
July 30, 1920.

Sheet #3 (of 4 Sheets.)
File:- 307-6

Revisions.

April 13, 1921. Circuits as shown Installed:- Apr. 1, 1921.

Apr. 1921. Installed.

Designed by G.H. Dryden.
Drawn by Wm. A. Covey.
Traced by Wm. A. Covey.
Checked by Wm Jennison.

Drawing 307-6 Sheet 4 was missing from original document